Cleaner is cheaper

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case studies of corporate environmental excellence

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Foreword

Corporate social responsibility (CSR) is no longer a subject of concern only to social activists. It is very much a part of the direct business interest of corporate organizations themselves. Mahatma Gandhi, almost three quarters of a century ago, enunciated the concept of trusteeship in private ownership of capital. In his view, industrialists were expected to behave like trustees protecting the interests of the public, which is ultimately the source of capital for business and industry. Today, we are, perhaps, coming round full circle in emphasizing this concept through an articulation of the principle of CSR.

Why should companies whose major objective has been to maximize profits for the benefit of their shareholders worry at all about serving the interest of society at large? The answer is simple and yet somewhat circular in nature. A business cannot succeed in a society which fails. This, therefore, clearly establishes the stake of a business organization in the good health and well-being of a society of which it is a part. More importantly, in this age of widespread communication and growing emphasis on transparency, customers of any product or service are unlikely to feel satisfied in buying from a company that is seen to violate the expectations of ethical and socially responsible behaviour. We find, therefore, that, to a growing degree, companies that pay genuine attention to the principles of socially responsible behaviour are also favoured by the public and preferred for their goods and services.

CoRE–BCSD, India (Corporate Roundtable on development of strategies for the Environment and sustainable development–Business Council for Sustainable Development), has developed as a unique grouping of corporate organizations that are trying collectively and individually to build in sustainable development concepts in their operations. CoRE–BCSD, India, includes some of the most innovative, some of the largest, and also the most forward-looking organizations in the country. The objectives of sustainable development rest within the principles of CSR, because unless the needs of society, both present and future, are served, sustainable development would remain only a holy grail. And the most significant step in pursuing CSR is to proactively protect the environment.

It is, perhaps, for the first time in India that case studies dealing with corporate environmental excellence are being published. The range of operations and subjects covered in the 33 case studies in this volume is vast and diverse. If they can set an example of CSR, other units throughout the country would follow by emulating them. The material presented in this volume rises to a level of practicality generally unseen in textbooks on the subject. There is no doubt that the inspiration provided by the record of successful environmental responsibility would be much more compelling than any advocacy on the basis of ethical or moral principles or, for that matter, even on the basis of legal or regulatory requirements. It would also be found from a perusal of these case studies that while improving the environment, the corporates included in this volume have also served their business interests and actually made money from their actions. Perhaps, this is an important conclusion for other corporate organizations to keep in mind and for those involved in advocacy for responsible corporate behaviour to use as an argument in favour of enlightened and responsible corporate decisions.

(R K Pachauri)
Director-General, TERI

Preface

The corporate sector is emerging as a critical player in our country's development process. Realizing the increasing problems facing the environment, corporates have recognized their responsibilities towards it. Facing the new demands from more stakeholders, corporations have realized that if they implement cleaner practices, they will be able to respond more aggressively to competitive pressures and anticipate customer needs. Today, many solution-oriented organizations countrywide are successfully taking positive actions towards environmental sustainability. Throughout the world, however, these actions are largely unrecognized, defeating opportunities for others to follow their example. Such programmes need to be recognized and promoted to lead others towards an environmentally sustainable future.

TERI has achieved a unique distinction not only as a premier research institution working in the fields of energy, environment, sustainable development, and corporate social responsibility but also as an agent of change. It has taken up issues related to sustainable development and social responsibility for the Indian corporate sector. To carry this forward, TERI has formed the CoRE–BCSD, India (**Co**rporate **R**oundtable on development of strategies for the **E**nvironment and sustainable development–**B**usiness **C**ouncil for **S**ustainable **D**evelopment), where 47 leading corporates have come together to identify problem areas in the field of industrial sustainability and help develop strategies for addressing them in association with the WBCSD (World Business Council for Sustainable Development), Geneva, Switzerland.

This publication is the first in a series on business cases highlighting best practices in the Indian industry. Good environmental performance and cleaner initiatives undertaken by the corporates form the basis for the selection of these case studies. These case studies clearly convey that the environmental measures are not unjust investments and environmental management is relevant for the long-term sustenance of large companies. Experience has shown that small- and medium-sized companies benefit from implementing environmental measures, and that environmental benefits translate into financial benefits.

There are numerous companies that are undertaking extended and impressive efforts yet for the purpose of brevity only 33 figure in this book. The case study collection is intended to inspire others to contribute, in a proactive way, to sustainable development. We will all benefit by sharing success stories.

TERI is grateful to the organizations that have expressed interest in sharing their best practices and initiatives.

Acknowledgements

TERI is thankful to each and every corporate organization for submitting its case study for publication. The number is too large to be listed out here. There have been a number of people who have contributed to this publication and TERI would like to thank everyone for their time, effort, and help in making this publication a success. Thanks are also due to all the editors, especially Ms Atreyi Paul and Mr Arvind Sharma for their substantial contributions.

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Introduction

No strategy of development can be conceived of in static terms. It must provide for changing responses to changing circumstances—this, in brief, has been the crux of survival as well as success for leading Indian corporates in a globalizing economy. To maintain the cutting edge in the face of stiff global competition, there has been a new wave of corporate governance in the country focusing on greater accountability, effectiveness, and transparency.

This has primarily been in response to two driving factors. The first is the changing attitudes of a more discerning consumer society. The other is the growth of the information society. In this age of information technology, no business house can escape the public eye. As the visibility and value of brands grow due to globalization, so does the risk of damage to a company's reputation. Therefore, transparency of operation and accountability is critical to a company's success. The Indian industry has grappled with these emerging trends of corporate functioning to improve its standing in the international market. There is a growing realization that sustainable business cannot come about by following the traditional thinking that the only thing that business has to do is make profit. The role of business now entails not just making profit but also managing issues that concern many stakeholders, which essentially is a much wider community than just shareholders. Managing these concerns will enable the company to continue to make a profit.

The business-society linkage

Following this realization, the social obligations of corporate houses are becoming an integral component of their business agenda. CSR (corporate social responsibility) is now recognized to be more than just a philanthropic gesture. It ensures the long-term prosperity of companies by providing the opportunity to demonstrate the human face of business—a vital link to society, in general, and to communities in which businesses are located, in particular. This new and expanding role of the corporate bears great developmental implications for society and is critical for establishing sustainable forms of economic growth in the country as a whole. The emergence of CSR is particularly relevant for billions of people who have been left out of the world's longest economic expansion. Access to fundamental needs such as clean water, shelter, sanitation, and nutritious food is limited to a small section of human society, leaving the larger part of the population in abject poverty and deprivation. Poverty, with its various ramifications, is devastating for the environment and for business the vast population of the poor represents lost opportunity. Therefore, business must work creatively with governments and civil society to improve the quality of life for everybody with the ultimate objective of developing and strengthening human resources, creating new markets, and spreading good will.

The business–society linkage is intricate and it includes a whole gamut of issues ranging from environmental and social fallouts of businesses to corporate governance. Just as society depends on the economy, the economy too depends on the global ecosystem, whose health represents the ultimate bottom line. This in itself embodies the concept of a growing notion in the

business world known as the 'triple bottom line'. In its broadest scope, the term is used to capture the whole set of values, issues, and processes that companies must address in order to minimize any harm resulting from their activities and to create economic, social, and environmental value.

TERI's initiatives

Against this background of revolutionary changes in the approach to doing business, TERI has been one of the pioneering institutes in understanding the changing dynamics of the Indian industry in its relationship with society and the environment. The organization has actively promoted concepts of sustainable business practices and assisted the Indian industry in identifying issues related to the environment and sustainable development. Through its network of 47 leading Indian corporates, called the CoRE–BCSD, India (Corporate Roundtable on development of strategies for the Environment and sustainable development–Business Council for Sustainable Development), TERI has initiated the learning-by-sharing programme to develop inter-sectoral synergies in the area of energy, environment, clean development mechanism and CSR. In line with these initiatives, TERI has also instituted the Policy Seminar Series, which deals with diverse emerging subjects of national and international concern. The aim of this initiative is to move ahead by widening the knowledge base and to share success stories, hurdles and experiences among the corporate sectors, public sector undertakings, and the government. It would also provide a platform for exchanging views on theories and practices among corporates, scientists, policy-makers, and researchers. In its endeavour to promote excellence in Indian industry, this publication is yet another initiative of TERI to generate awareness and propagate environment-friendly and socially relevant ways of doing business.

About the case studies

This book is the first in a series on business cases highlighting best practices in the Indian industry. It is for the first time that such a publication has been brought out exclusively on the Indian industry, and which focuses on their contribution towards sustainable development through their varied initiatives aimed at conservation of resources, minimization of waste, and improvement of environmental standards. These case studies have been chosen to demonstrate the leadership provided by the business community in going beyond regulations and setting new standards in India and the world. It presents the 'first-evers' in the Indian industry. Apart from portraying environmental profiles of some of the industries in India, it also provides insights into their environmental concerns and innovative practices that have helped to accomplish environmental ends.

The objective of the book is to provide viable solutions to industries faced with environmental problems and inform industrial managers of state-of-the-art technologies and practices. The volume provides an invaluable database of replicable models for units faced with similar environmental challenges. Apart from highlighting the growing environmental considerations in Indian industry, each of these cases are exemplary instances of how sound environmental practices have led to enhanced economic performances. The book challenges the traditional notion of the environment–industry dichotomy and emphasizes the critical requirement of environmental integrity of business for its long-term sustenance and prosperity.

Structurally, the book covers a broad expanse and draws case studies from diverse sectors, ranging from highly polluting industries such as fertilizer, paper, and mining, to businesses promoting environmental entrepreneurship. It cuts

across manufacturing and the service sectors. In all, this volume has compiled 33 different case studies representing the entire cross-section of the Indian industry. For easy referencing, the cases presented in the book have been classified under five broad sections: water conservation, resource conservation and waste management, process improvement, environmental management systems, and a combined section on land reclamation and environmental entrepreneurship.

Water conservation

Water conservation has been one of the important initiatives taken by many industries. Albeit, the main driver in all these cases has been the scarcity of this precious resource but the ingenuity demonstrated by the companies in dealing with the problem has been highlighted through these case studies. While most cases in this section demonstrate initiatives towards 'zero discharge', E I DuPont India at its Savli operations has gone a step further to achieve 'zero effluent'. The DuPont facility at Savli in Gujarat manufactures engineering polymers that required large amounts of water. Local circumstances, however, exerted severe water constraints and the only other option was to relocate the plant. A team of Savli site personnel together with a Japanese compounding expert overcame this constraint by successfully re-engineering their vacuum extracting system and reducing their water consumption by 99.5%. This has led to a net benefit of 5000 dollars annually through water saving. Besides circumventing the problem of relocation, it also improved the efficiency of the extraction system and set a new global benchmark for water consumption for this product line.

The CPCL (Chennai Petroleum Corporation Ltd) case study truly epitomizes ingenuity in the face of adversity. In the late 1980s, the company had been forced to suspend its operations due to raw water scarcity. The problem of water availability was resolved in 1991, when the company set up a city sewage reclamation plant to meet 40% of its raw water requirements by installing a tertiary treatment plant coupled with RO (reverse osmosis). This initiative was the first of its kind in Asia. In 1992, the CPCL upgraded its ETP (effluent treatment plant) by installing UF (ultra filtration) with RO and reused 100% of its effluent in its operations. The recycling of industrial effluent was an engineering feat as, unlike sewage, composition of industrial effluent is likely to fluctuate, increasing the probability of RO membrane poisoning with subsequent breakdown of the treatment system. The development of the treatment system has come about in phases and a result of considerable research. The CPCL has now switched over to the use of indigenous RO membranes. Apart from resuming operations under the most adverse conditions, the CPCL has achieved zero effluent, reduced energy consumption by adopting UF technology and eliminated sludge generation from its effluent treatment plant through its chemical-free effluent treatment.

IFFCO (the Indian Farmers Fertiliser Cooperative) Ltd has adopted a similar initiative for recycling industrial effluent using RO technology at their Phulpur unit. Such an initiative is unique in the fertilizer sector and has received widespread recognition. The operations at Phulpur have made a great difference in the surrounding farming community through their agricultural extension and fertilizer use programme. IFFCO, Phulpur, has successfully converted the surrounding barren land into a lush green area.

The case of SPB (Seshasayee Paper and Boards) Ltd provides a fresh dimension to water conservation and waste utilization. Located in a rain shadow area, in the midst of an agrarian community, the company has implemented a

well-conceived irrigation scheme utilizing the waste water generated in the paper mill. This irrigation scheme is of particular relevance to the needs of the farming community as they are vulnerable to the erratic nature of the monsoons. Besides ensuring a reliable supply of nutrient-rich waste water to the farmers, this scheme serves to dispose of treated waste water in a useful manner. Research conducted in collaboration with the Tamil Nadu Agricultural University has put to rest the concern of groundwater contamination arising out of this practice. The use of treated waste water for irrigation has a fertilizing effect on sugar cane production and also serves to reduce colour, which persists even after conventional treatment. The sugar cane produced by the farmers is supplied to the neighbouring Ponni Sugar Mill, which is a sister concern of the SPB, while the bagasse generated by the sugar mill is used for paper making at the SPB. This unique partnership established with the local community for supply of sugar cane in return for waste water illustrates the innovative exploitation of synergies between society and business leading to increases in social as well as environmental value of the company's operations.

The Orient Paper Mills has implemented a similar model of waste water management known as HRTS (high rate transpiration system). HRTS entails land treatment of coloured waste water. This treatment has proved to be cost-effective as well as environment-friendly as it eliminates the discharge of coloured effluent into the river. The company plans to use this waste water to develop social forestry programmes with community participation, which would provide raw material for the company's operations.

Waste management and resource conservation

Many a small initiative can go a long way towards reducing environmental footprints. The section on waste management and resource conservation demonstrates just that. This section presents a few cases from some of the most polluting sectors of the Indian industry such as power generation, refractories, and mining. A small change in the type of lubricant used at the BSES power generation unit at Dahanu, Maharashtra, reduced their lubricant consumption dramatically leading to a decrease in waste lubricant generation from 24 barrels to a mere 3 barrels a month. Moreover, by using the new lubricant, it was possible to recycle the spent grease from the process, which further cut down on the quantity of waste generated. Apart from the environmental benefits from reduction in hazardous waste, the direct cost saving that resulted from this switchover in lubricant was 0.85 million rupees per annum.

At the Hirakud unit of the Indian Aluminium Company Ltd, a change from mercury arc rectifiers to thyristor-based rectifiers eliminated the use and handling of 1.5 tonnes of hazardous mercury and reduced the use of fluoride-based chemicals from 67 kg/tonne of aluminium to 49 kg /tonne of aluminium. Additionally, the use of thyristor-based rectifiers satisfied the increasing demand for electricity and improved energy efficiency while reducing wastage. This was the first domestic aluminium plant to use thyristor-based rectifiers.

Particulate emissions in refractories are the main air pollutant and pose a serious threat to the health of employees. Workers in the silica plant are exposed to quartzite dust, which increases the risk of silicosis, a lung disease. Various attempts were made at the Tata Refractories Ltd, Belpahar, to control particulate emissions. Most of the abatement instruments proved ineffective in

reducing the dust levels below a certain point. Motivated to improve on the regulatory norms, mechanical shaker-type bag filters were replaced with pulse jet filters. The change in the abatement technology helped bring down the dust levels below the regulatory norm of 7.5 mg/m^3 to 2 mg/m^3 and, at the same time, reduced energy consumption. Further, the dust that collected in the filters was reused in the manufacturing process, increasing the efficiency of raw material utilization.

The case presented by Shriram Alkali & Chemicals for their Jhagadia unit demonstrates the resourcefulness of the company in developing pro-ducts from waste through recycling and reuse. In doing so, they have not only generated additional revenue but have also prevented the release of hazardous waste into the environment. As a result of their efforts, the effluent generated from the unit has progressively decreased over the years. One of the striking initiatives has been the segregation of the ion exchange column regeneration effluent into acidic and alkaline streams. The chemicals in the two separate streams can be used as substitutes for hydrogen chloride for barium chloride production and sodium hydroxide in the brine reactor. This has been done at a cost of 80 000 rupees and has resulted in effluent reduction by 35 m^3/day. This treatment system developed in-house has been presented as a model by their Japanese engineering consultants for other similar units.

Process improvement

Several industries have undertaken in-house R&D initiatives to improve on the production process either to enhance efficiency or to reduce the generation of hazardous waste. The cases presented in this section illustrate a continuous drive for excellence. The Grasim Staple Fibre Division at Nagda, through its in-house R&D efforts, has set new standards for the manufacture of viscose staple fibre worldwide. They have not only eliminated zinc, a hazardous material, from the process but have also developed a technology to use the ETP sludge as fuel in boilers. About 90% of the solid waste generated in the plant is used as fuel for boilers, thus reducing the consumption of coal. Further, Grasim, in collaboration with Birla Research Institute of Applied Sciences, has developed a new technology that produces cellulosic fibre more efficiently by reducing the chemical requirement, and forming no hazardous by-products. This process has given them a commercial advantage over the currently used viscose production process. The SBL (Sundaram Brake Linings) Ltd has made its operations more environmentally benign by converting to a new production technique, which reduces solid waste generation and energy consumption. The new technology also ensures fewer product rejects and improves the quality and consistency of the product. They are consciously moving towards the production of asbestos-free products, thereby reducing the use of hazardous chemicals. At present, 45% of SBL's products are asbestos-free.

Environmental management systems

The section on environmental management systems describes initiatives spanning the entire scope of operation at a production unit. It serves as an indicator of the extent to which environmental concerns have governed the design of the system of operation. It covers diverse operations ranging from mining and iron and steel production to the production of solar panels. The BG Exploration and Production Ltd, at its offshore drilling sites, has highlighted some of the initiatives taken to reduce the impact of their operations on the marine environment. The steps taken to reduce oil spills through drill discharges as well as otherwise set a standard for all oil-drilling operations. The

BG Exploration has reduced flaring of gas in a systematic manner to save about 850 000 m^3/day of precious natural gas.

The Mahanadi Coalfields Ltd, similarly, describes environmentally conscious coal mining. A striking feature of the mining practice is the process of land reclamation. The early back-filling coupled with the regeneration of topsoil using biotechnology to conserve land fertility is commendable.

Praxair India Private Ltd at its Sriperumbudur facility has implemented a state-of-the-art MPC (model predictive control) system to optimize the steady-state operation. It is for the first time in India that an MPC has been successfully implemented in an air separation plant. This computerized system of operation has reduced pollution and enhanced energy efficiency. Through its Sriperumbudur facility, the company has set a new standard for itself, which the other facilities have to measure up to.

Gujarat Ambuja Cement Ltd has described in detail the measures taken to reduce particulate emissions from point as well as fugitive sources. This effort is of great significance as the control of particulate emissions in a cement unit is a sizeable challenge.

Land reclamation and environmental entrepreneurship

The section on land reclamation and environmental entrepreneurship presents four cases, which are exemplary in the nature of the projects undertaken. The green-belt development by the Nagarjuna Fertilizers and Chemicals Ltd is commendable in its approach to meeting the challenge of greening barren land. It was an uphill task requiring much research. The case stands out for its successful attempt at creating a mini ecosystem out of nothing at all.

The case of Vestas RRB India Ltd has been much appreciated for the development and implementation of a viable renewable energy project for the industry. It represents a pioneering effort in spreading renewables in Indian industries.

The work of Biodiversity Conservation (India) Ltd also represents a new genre of business advocating sustainable development. It transcends the conventional business concepts and is a leader in promoting environmental entrepreneurship.

About CoRE-BCSD, India

CoRE-BCSD, India: working towards a cleaner and greener corporate vision

Introduction

CoRE (**Co**rporate **R**oundtable on development of strategies for the **E**nvironment and sustainable development) is a network of motivated and socially conscious corporates that have come together to identify key problem areas in the field of industrial sustainability and develop strategies for addressing them. An initiative by TERI, CoRE's mission is to set up an independent and credible platform for corporate leaders to address the dual objectives of environment protection and economic excellence. Subject experts from member corporates identify and conceptualize projects and a team of industry members and TERI researchers then works to develop appropriate solutions and strategies for use by the industry. The work undertaken by CoRE is devoid of any ideological or political bias.

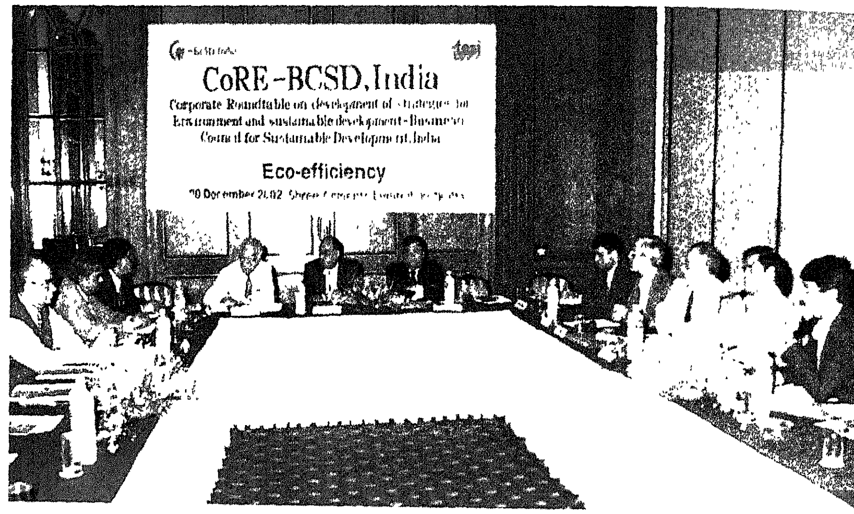


Members of CoRE-BCSD, India

Inaugurated by the Hon'ble Minister for Environment and Forests, Mr T R Baalu, in February 2000, CoRE currently has a membership of 47 leading Indian corporates (Annexe 1). Some of the sectors represented by the members are oil and gas, cement, fertilizer, chemicals, automotive manufacturing, and power. CoRE is now a partner to the WBCSD (World Business Council for Sustainable Development), Geneva, Switzerland. It has signed a memorandum of understanding with the WBCSD and is now called CoRE-BCSD, India. This interface between TERI and the WBCSD provides an important link to addressing issues of corporate environmental management and sustainable development at a global level and to learn and exchange best practices among the various corporates.

CoRE-BCSD, India disseminates and shares information related to corporate environmental management and sustainable development. CoRE-BCSD, India, provides the following services to its members.

- Weekly e-mail news service called CoRE clips
- *TerraGreen*, a fortnightly e-zine
- Specific referral service and project work relating to the environment and sustainable development



A CoRE-BCSD, India meeting on 'Eco-efficiency'

- Its newsletter called *EnCoRE*, which features a lead article by an eminent person working in the area and includes contributions from member corporates.

Besides, it also organizes regular meetings and workshops involving all its members. The schedule of meetings and workshops is as follows.

- Annual CEOs' meeting where the companies' CEOs would be invited to chalk out a road map for their activities
- Annual steering committee meeting
- CoRE-BCSD, India meetings (thrice a year) on a focal theme

Project activities

Sectoral studies

CoRE-BCSD, India intends to carry out sectoral studies on sustainable development with reference to various stakeholders. The sectoral studies would envisage studies in various sectors, such as cement, oil and gas, fertilizer, and power.

VISSYN programme

CoRE-BCSD, India has also undertaken the VISSYN (Voluntary Inter-Sectoral SYNergy) programme. VISSYN is a learning-by-sharing programme. It was launched to facilitate learning by sharing through site visits and exchange of information on technical, environmental, and other issues. In an emerging world characterized by globalization and liberalization, market synergies within and across sectors are essential. The programme has the following objectives.

- Fostering creativity and innovation for providing 'out-of-fence' solutions on issues related to the environment, energy, CDM (clean development mechanism), and CSR (corporate social responsibility).
- Developing inter-sectoral learning modules for continual improvements and building capacities for ISO certifications.
- Sharing of experiences for going beyond mandatory compliance for energy and the environment laid down by the pollution control boards and the Bureau of Energy Efficiency.
- Identifying opportunities and generating project proposals for technology and upgradation of projects with international/national green funds under CDM (Clean Development Mechanism) and PCF (Prototype Carbon Fund).



Mr Franz Tatenbach, Member, Clean Development Mechanism Executive Board, addressing members of the CoRE-BCSD, India, at the eighth session of the Conference of Parties

Inter-sectoral teams have been formed to meet the above objectives and have a corporate nominee in each of the functional areas dealing with issues on the environment, energy, CDM, and CSR from member organizations. These inter-sectoral teams visit each other's facilities, conduct studies, make recommendations for improvements, and carry back the learning for implementation with adaptations in their own organization.

Eco-rating

The value of an efficient and effective environmental performance tracking system lies not just in meeting external information and disclosure requirements but also in gaining a better insight into the system's operations and managing risks more effectively. Eco-rating of a facility aims at providing an indicator of environmental performance and the risk associated with corporate facilities. The rating of such performances would be seen as 'green' equivalent of a credit rating system. It would be a tool that people can use to independently gauge environmental performance and risk associated with a corporate facility.

A detailed rating model would use sector-specific indicators. Benchmarks against national and global standards would be incorporated and would entail sector-specific testing at live facilities. It would involve industry experts to ensure the practicability of the system and would also facilitate voluntary disclosure of the rating obtained. The rating could be used as the first step towards ISO 14001 certification. Certified units, on the other hand, may be used to monitor their performance over time. The scope of eco-rating would cover

- environmental pollution,
- resource intensity,
- work environment,
- contingency management systems,
- environmental management systems, and
- social issues addressed by the organization.

Planned activities

Environmental, CSR, and sustainable development reports

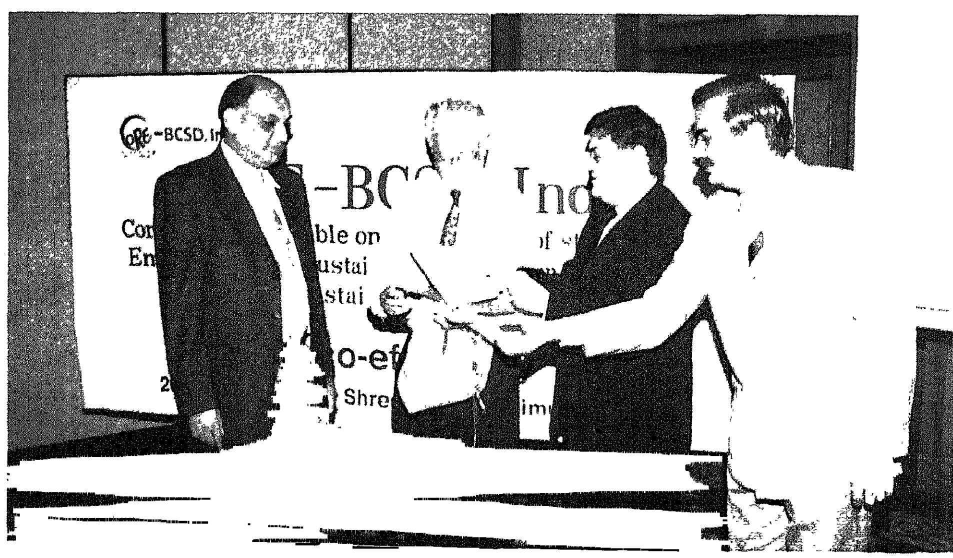
Reporting forms a major step for corporates to take action and also acts as a medium to disseminate information to various stakeholders. Though environmental reporting to the regulatory authorities is mandatory, more and more companies are now reporting their environmental and other social initiatives independently and voluntarily in the form of annual statements, publications, and newsletters. This reporting provides a medium for communication on the

company's achievements and activities in these topical areas and builds in a corporate image that is green and responsible. In this regard, TERI, with its wide range of research and publishing expertise, would help corporates in the formulation of these reports and in the compilation of information relating to the corporate's environmental, social responsibility, and sustainable development practices.

Access to water

Water is essential in the food supply chain and for business operations. Water supply and basic sanitation are crucial for sustainable development and for the growing urban areas around the world. As a forum of industry members, CoRE-BCSD, India would

- help position industry as a proactive player in managing and using fresh water;
- promote best practice in water use and conservation within the corporates and also to promote public–private partnerships to manage and conserve water outside the corporates; and
- focus the attention of the working group from companies on the need for a sound framework in developing countries to encourage private sector investment and involvement in water supply and services.



Release of a publication on water conservation (from left to right: Mr H M Bangur, CEO, Shree Cement Ltd, Mr R K Narang, Distinguished Fellow, TERI, Mr M K Singhi, Vice President, Shree Cement Ltd, Mr R Bhargava, Assistant General Manager, Shree Cement Ltd)

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Water Conservation

1
Chennai Petroleum Corporation Ltd

2
E I DuPont India Ltd

3
General Motors India Private Ltd

4
Indian Farmers Fertiliser Cooperative Ltd

5
Mangalore Refinery and Petrochemicals Ltd

6
Orient Paper Mills

7
Samcor Glass Ltd

8
Seshasayee Paper and Boards Ltd

9
Shriram Fertilisers & Chemicals

CASE STUDY 1 Chennai Petroleum Corporation Ltd

Background

The foundation of the CPCL (Chennai Petroleum Corporation Ltd) was laid in 1967 by the then Prime Minister of India, Mrs Indira Gandhi; the company later became the 'petro star' in the Indian oil and gas sector. A port-based refinery, the CPCL was formed as a joint venture of the Government of India, the Amoco India Inc., and the National Iranian Oil Company. The CPCL has a 7.5 MTPA (million tonnes per annum) capacity and manufactures liquefied petroleum gas, motor spirit, superior kerosene, aviation turbine fuel, high speed diesel, naphtha, bitumen, lube base stocks, paraffin wax, fuel oil, and hexane. It also supplies petro-chemical feedstock like propylene and C4 stream. Besides, the CPCL has contributed to the vitality of many related industries enabling them to blossom into manufacturers of products as diverse as fertilizers, additives, and a host of other petro-based products. The annual turnover of the company is about 72 billion rupees.

The CPCL started its operation in Manali and in 1993 became multi-locational with the commissioning of a grass-roots refinery at Panangudi, Nagapattinam, in the Cauvery basin. The Manali refinery contributes to majority (6.5 MTPA) of the installed refinery capacity and it is here that the company has undertaken the environmental project for reuse of effluent water in process operation, thereby achieving the status of zero effluent discharge.

Environmental profile

The company is environmentally proactive and seeks to maximize profits in a reliable, ethical, and socially responsible manner. With a dedicated environment department in place, it strives to constantly improving pollution prevention and control measures, conserving energy, using cleaner technology in refinery process operations, and promoting environmental awareness among employees, customers, and the neighbourhood.

In 1991, the CPCL became the first company in Asia to put up a city sewage reclamation plant to meet 40% of its raw water requirements by installing a TTP-cum-RO (tertiary treatment plant-cum-reverse osmosis) plant. The Manali and Cauvery basin refineries are ISO 14001 and ISO 9001 certified units. Manali is also certified for OHSAS 18001 for occupational health and safety management systems.

The company has an exemplary track record in the environmental field and has implemented various environmental conservation measures from time to time. Major environmental initiatives taken by the CPCL in the past are discussed below.

- The CPCL upgraded its effluent treatment plants in 1992 to meet the minimum national standards and the IS 2490 standards. In order to avoid heavy metal pollution in the effluent from the refinery, the company switched over to non-metallic treatment in cooling towers. It has also set up a field water lab and an R&D lab for water monitoring. The company installed a reclamation facility for treated effluents for process use.
- The CPCL increased the height of stacks to a minimum of 60 metres for dispersion of flue gases. It has installed a sulphur recovery unit with the

technology of Maximum Clauss recovery process so as to recover more than 90% elemental sulphur from acid gases. A flare gas recovery unit is in operation for recovery of hydrocarbons emitted to the atmosphere. Floating roof and secondary seals installed in the plant for the storage tanks meet the stipulated standards for fugitive emissions. Six complex state-of-the-art ambient air quality monitoring stations have been commissioned for pollutant and meteorological monitoring.

- Techniques for sludge minimization and recovery of oil from sludge in tanks have been implemented by means of hot gas oil re-circulation, maintaining high temperature in BH crude tanks, and chemical treatment in crude storage tanks.

Through reduction in consumption of water, energy, and raw material, the company has attempted to conserve resources at all levels.

The CPCL has been a member of national and international forums wherein environmental issues at global levels are addressed. Some of them are listed here.

- CoRE-BCSD—Corporate Roundtable on development of strategies for the Environment, spearheaded by TERI and the World Business Council for Sustainable Development
- World Environment Foundation
- Asia-Europe roundtable meet on 'Building Synergy between Business and Environment for Sustainable Development'.

For effective execution of its environmental policies, the CPCL has been honoured with many international and national awards, which include the Golden Peacock Environmental Management Winner Award for the year 2000/01 from the World Environment Foundation and awards from both state and central pollution control boards.

Case study

The CPCL has initiated an ecosystem management project at its Manali refinery. The programme is on for more than two years now and involves a capital expenditure of more than 46 million rupees. The state-of-the-art technology of UF (ultra-filtration) and RO is used in the plant for reclamation of the industrial effluents, which is reused as process water.

A total of 350 m^3/hour of refinery effluents are treated in the effluent treatment plants at the Manali refinery. Sixty per cent of the treated water is reused for various peripheral applications in the refinery such as firewater make-up, cooling tower make-up, floor washing, green belt development, and construction work. Earlier, the remaining 40% (150 m^3/hour) of the treated effluents was being disposed of into the Buckingham canal. The CPCL examined various technology options in order to recycle the entire treated effluent water for process rather than peripheral applications and also for meeting the raw water requirements of the plant to achieve a zero discharge situation.

The first technology explored was the conventional RO pre-treatment followed by RO. Subsequently, the UF as RO pre-treatment followed by RO was also examined. Two other schemes such as photo-chemical oxidation and high-efficient RO were also tried as part of the research.

The techno-economical equation of the UF process was found viable. The suitability and superiority of the UF technology for pre-treatment of RO feed

in line with latest technologies for water treatment was demonstrated through pilot studies for over a year and a half. The project with UF had unit operations such as chemical pre-treatment with ferric chloride, dual media filtration, and UF. The treated water from UF was then passed through the existing RO bank.

The CPCL gained various technological advantages, as listed below, by adopting the UF technology over conventional technologies.

- Low energy, chemical, and manpower requirements
- Time saving due to avoidance of functions like purchase, transport, and handling of RO pre-treatment chemicals
- Better permeate quality and increase in permeate recovery
- Ease of operation
- Modular nature of the project, which lends itself to expansion at later stages
- Minimum sludge generation
- Consistent RO feed water leading to low fouling and enhanced life of RO membranes.

The effort brought some significant environmental benefits as expected. Some of them are highlighted here.

- Water resource conservation through saving of metro raw water, which can be diverted to the water-starved city population
- Environmental hygiene, as zero discharge avoids disposal of even treated effluents into water bodies
- Minimization of sludge generation and its disposal, as the project is based on technology of membrane separation of contaminants, which brings down energy and chemical requirements *vis-à-vis* conventional chemical treatment
- Providing an alternative to the existing TTP process
- Potential RO pre-treatment also for secondary treated sewage water
- Reuse of 40% of treated effluents as raw water
- Saving of 20 million rupees due to zero discharge of effluents

Other than the significant environmental benefits of the project, the key drivers for adoption of the programme were availability of latest technologies and processes, expected scarcity of water in coming years, and a concern for the environmental consequences due to growing population around the complex. The company's pioneering background in water treatment and conservation gave a leading edge to the corporate image of the company by establishing that it is a torch-bearer in terms of environmental performance.

The main challenges faced during the implementation of the project were the financial limitations in view of the changing market scenario and evaluation and implementation of alternative technologies for pre-treatment of effluents so as to find the best possible techno-economic solution.

The initiative of the CPCL provides a model to other petroleum and allied industries, especially when the shortage of water resource is a global environmental concern and putting in use alternative water resources is the need of the hour.

Case study at a glance

The environmental efforts undertaken by the CPCL (Chennai Petroleum Corporation Ltd) show that the success of any environmental initiative lies in the commitment and in-depth approach of the management. By a combination of technologies, the company has successfully demonstrated a zero effluent discharge refinery and conservation of scarce water resources by recycling treated effluents for process use. The economic appeal of the project lies in its cost saving, resource saving, and commercialization potential.

Over the last two years, the company has successfully leveraged its environment management system for improving environmental standards and resource conservation. A growing concern for the population living around the plant as well as future water shortage have prompted the CPCL for a capital investment of 46 million rupees.

Through the use of UF (ultra-filtration) for pre-treatment of treated effluents and other unit operations such as chemical pre-treatment with ferric chloride, dual media filtration, and ultra filtration, the project payback was reduced to less than two years. Some significant aspects of the initiative are listed below.

- It saves resources, as 150 m^3/hour of treated effluent is meeting the raw water requirements of the plant.
- Resource saving of metro raw water has also been achieved, by recycling treated effluents for use in the process.
- The UF technology can also be an effective pre-treatment for RO (reverse osmosis) treatment of sewage water.
- With the implementation of the zero discharge project, the discharge of effluents is nil from the refinery campus.
- Also avoids the disposal of treated industrial effluents into water bodies thereby protecting the environment and improving environmental hygiene.
- Reduces usage of chemicals and energy thereby ensuring a cleaner environment as well as resource conservation.
- Use of eco-friendly process such as UF for pre-treatment of RO feed in line with latest technologies in water treatment. The same was demonstrated through pilot plant studies over a period of one and a half years. Techno-economically, UF has been found viable.

CASE STUDY

2 E I DuPont India Ltd

Background

DuPont India Ltd, a part of the worldwide DuPont group, manufactures and markets Tynex PA612 monofilament, Teflon Finishes formulation, engineering polymers (Zytel and Delrin), insecticides formulation and packaging, and herbicides formulation and packaging. The company has two wholly owned operating sites at Madurai, Tamil Nadu, and Savli, Gujarat. It undertook its zero effluent waste water project at the Savli site in Gujarat.

There are in place seven codes of management practices, which deal with process safety, pollution prevention, distribution, community awareness, emergency response, employee health and safety, and product stewardship. The company has devised a procedure for identifying the environmental aspects and associated impacts of its operations under normal, abnormal, and fairly foreseeable emergency conditions.

The identified aspects are evaluated using criteria based on the quantity of release of pollutants or consumption of resources; nature of pollutant released or nature of substance being consumed. The severity of impact is then evolved. This is then classified as high significance, medium significance, or low significance. The aspects associated with impacts having high and medium significance are considered in the setting of objectives and targets. In addition, the environmental policy, the legal requirements, the technological options, and the financial, business and operational requirements are considered in the setting of objectives and targets.

Environmental profile

The company is committed to conducting its operations with respect and care for the environment, and has in place a clearly defined environmental management system, both at the company and the facility levels. The system is based on the state and national legislative and regulatory requirements, the company's own corporate guidelines, and the ISO 14001 1996 standards. DuPont is an active participant in 'Responsible Care', in association with the Chemical Manufacturers' Association and is committed to supporting a continuing effort to improve the chemical industry's responsible management of chemicals through the Responsible Care programme.

The company has in place an SHE (Safety, Health, and Environment) committee with the site manager as the chairman of the committee. In addition, the committee also comprises a functional leader, a unit operational leader (crop protection products), a unit operational leader (engineering polymers), a process safety management coordinator, management representative for EMS (environmental management system), and various functional leaders.

Due to the environmental efforts undertaken by the company, its Savli engineering polymers site is among the 12 global accomplishments selected to receive the 2001 Sustainable Growth Excellence Award for creating safety, health, and environmental value, while also creating societal and shareholder value.

The company has consistently sought minimization of air and water pollution, conservation of resources through improvements in technology,

and greening of the environment. Under the minimization initiative, the company has installed systems to reduce spill control in its various units. It has minimized consumption of packing material and bulk losses at its various units and has reduced start-up waste of Delrin. It has also reduced the consumption of Zytel bags.

Under its conservation initiative, the company has taken active steps to minimize water consumption in its Zytel and Delrin operations. It has sought to limit pollution and conserve power use through increasing the throughput of Zytel, Delrin, Algrip, and Almix. On the energy front, the company has gone in for energy conservation measures and an energy audit.

In 2000/01, *Swasthya Kiran*, a model community health and hygiene project was initiated for upgrading of drains and sewers in a nearby village at a cost of 26 000 dollars.

Case study

The project was initiated as an EP (engineering polymers) Savli compounding operation. A team was formed consisting of Savli site personnel, an EP Japan compounding technical expert, and an Indian environmental consultant. This team, through their collective knowledge and creativity, were able to redesign the entire vacuum extraction system for the Zytel process and essentially eliminate water consumption, and ensure that the small amount of water effluent met with requirements for site general purpose use, i.e. zero waste water effluent.

Due to the new process, water consumption was reduced by more than 99.5% and this process improvement is leverageable to the 70 similar processes worldwide. Water effluent from the site was eliminated and all water was consumed for site general-purpose requirements, thereby leading to a saving of 5000 dollars per year in potable water purchase.

The 'old process' for GRZ (glass reinforced Zytel) utilized the water-sealed vacuum pump system to extract low boiling materials. This process used a substantial amount of water for generating the necessary vacuum. The treating and disposal of waste water was also a major issue. The water quality provided by the Gujarat Industrial Development Corporation was also very high in total dissolved solids, resulting in frequent breakdowns and the need for stoppage for clean out.

The 'new' process replaced all this with a dry pump making a dramatic improvement in the condensation/knock-out system. Through modelling and a laboratory test-scale demonstration, an improved condensation/knock-out system was perfected that allowed operation with a dry vacuum pump. In addition, an overall site water effluent management system was designed and implemented to maintain the total water effluent quality and quantity at a level, which allowed its use for site general-purpose consumption.

The programme set new standards in terms of consumption of water in GRZ product compounding for DuPont operations worldwide. The project has been fully implemented since April 2000 and operating experience/data is being collected in preparation for application in other existing and new installations worldwide.

The main challenges faced during the project were the relative inexperience of the Indian team, which faced the impossible task of eliminating water consumption in the GRZ compounding process. The high capital cost of the project was another deterrent to the project. The company surmounted this through excellent regional and global networking coupled with innovative thinking prompted to a large extent by an excellent external consultant. The

management was also fully behind the project, in spite of the initial high cost of capital.

The key drivers for programme adoption were the fact that the plant was located within an industrial park with very strict water consumption and water effluent requirements that could not be met for the GRZ product compounding using existing technology. The organization thus had an option of correcting the situation within a specified time frame or relocation of the plant, which meant loss of jobs and loss of livelihood for the local people.

With this project, DuPont has increased shareholder and societal value while reducing incidents and its environmental footprint. The intangible but very important environmental payback for the company as a whole has been the establishment of the Indian team as one which can take up challenges and develop technologies that can be adopted by other DuPont companies the world over.

Case study at a glance

- DuPont India's Savli (Gujarat) facility was located in an industrial park, and had to adhere to strict norms regarding use of water and discharge of effluent.
- Previously, the plant was using a lot of water in the manufacture of one of its engineering polymer products, Zytel, and producing effluent as a result.
- Through the development of a new design for the vacuum extraction system for the Zytel glass reinforced process, the company could essentially eliminate water consumption and ensure that the small amount of water effluent met requirements for site general-purpose use, i.e. zero waste water effluent.
- Due to the new process, water consumption was reduced by more than 99.5%. Effluent from the site was eliminated and all water was consumed for site general-purpose requirements, thereby leading to a saving of 5000 dollars per year in potable water purchase.
- The appeal of the project lies in the fact that of about 70 process lines operating in DuPont globally, this is the first one to successfully adopt a design that essentially eliminates water consumption.

CASE STUDY

3 General Motors India Private Ltd

Background

The GMI (General Motors India) Private Ltd, part of the General Motors group worldwide, manufactures and markets passenger cars. The company has a single manufacturing unit located at Halol, Gujarat, where it has undertaken an environmental project for zero discharge from the plant and 100% recycling of the treated sewage waste water so as to conserve water.

Environmental profile

The GMI is committed to protecting human health, natural resources, and local and global environment in line with General Motors Corporation's global environmental principles. These are based on integration of risk-based cost-effective management practices into site activities with the aim of continually improving environmental practices. The GMI has in place an environmental policy at both the corporate and facility levels. Separate cells exist for both the environment and health and safety. The GMI enjoys the distinction of being rated as one of the top three green-rated companies amongst the automobile companies in India.

In accordance with the global common EPC (environmental performance criteria) to be followed and implemented by all GM plants worldwide, the Halol plant has a well-defined environmental system, which is in line with the requirements of ISO 14001 international standards. The company received this certification in July 2000. The GMI is in compliance with the EPC requirements, and implementation of the programme has resulted in better waste management practices (in both hazardous and non-hazardous wastes), water pollution control as well as resource conservation. All the company's products are compliant with Euro II norms, which have a closed loop evaporation emission control system. The company uses CFC (chlorofluorocarbon)-free refrigerants and environment-friendly pollen filters.

The environmental programmes are implemented across the plant through a cross-functional team consisting of representatives from all departments and headed by environmental management representatives (vice-president level) appointed by the managing director.

The GMI has always been an environmentally conscious and responsible corporate. The company had installed a most modern ETP (effluent treatment plant), with a high level of automation simultaneously with other manufacturing facilities in 1995/96. A huge storage tank with a capacity of 1300 m^3 for retaining the treated waste water and necessary pumps and underground piping, with water sprinklers, were installed for supplying water for lawns and gardening as well as for green belt development. Thus the company had from inception designed the plant to be zero discharge facility. This initiative resulted in recycling of more than 15 000 m^3 of water per annum as per current volumes.

The other environmental initiatives undertaken by the company in the past are given below.

Air pollution control initiative

The main sources of air pollution through process/flue gas exhaust stacks at the plant were the paint spray booth, incinerator, hot water generator, fuel tank spray booth, and the oven burners. The company installed the latest high technology equipment, the latest production processes, and used LPG (liquefied petroleum gas) so as to minimize air pollution. It has in place various treatment methods like scrubbers and filters to further reduce air pollution.

The major initiatives employed to reduce air pollution were the following.

- Installation of a highly efficient automatic electrostatic bell painting system to reduce paint consumption and hence emission of fumes significantly. Initially, the company had started out with air spray guns, which had a transfer efficiency of 30% and 70% of the paint was wasted. With the introduction of the turbo bell electrostatic automatic painting system and electrostatic guns, the paint wastage was reduced from 70% to 30% and they had a transfer efficiency of over 90%.
- By optimization of the area to be painted for fuel tank, the company reduced paint consumption and hence reduced fumes from the fuel tank painting booth.
- Usage of LPG, a cleaner fuel, for all baking and combustion applications throughout the plant further reduced pollution.

Water pollution prevention and control initiative

The main sources of waste water generation in the plant are the paint shop, RO (reverse osmosis) plant, cooling towers, softeners, and sewage waste water. The plant generates a daily average sewage waste stream of 50 kilolitres.

The process waste water from the paint shop is collected in separate lined RCC (reinforced cement concrete) sumps and is then transferred to the ETP. The waste water stream from the RO plant (30 kilolitres/day) has high total dissolved solids. It is partially taken to ETP and partially discharged into the retention pond, where it mixes with treated waste from ETP to meet the discharge requirements. For the cooling towers, a magnetic generator called Magnazen was developed in the US to eliminate or minimize chemical treatment of the cooling tower water. The company has been able to reduce the overall cooling tower blow-down to about 5 kilolitres/day.

From inception, the company established a modern ETP with adequate facilities for treating all pollutants present in effluents. The plant has a high level of automation with necessary on-line instrumentation like pH controllers and conductivity meters. Manual intervention in the plant is kept to a minimum.

The company undertook the following measures to combat waste water treatment.

- The treated trade effluent was 100% re-used for gardening and green belt development.
- The plant has laid out the necessary piping and pumps, etc. and other instruments for utilizing the treated sewage water along with the trade effluent.
- The company replaced the chrome-based passivation process (paint pre-shop treatment) by a chrome-free zirconium process to eliminate chrome bearing waste.
- It used an environment-friendly biodegradable solution for degreasing process in the entire pre-treatment.
- The company adopted minor process modifications and other waste minimization practices, which resulted in reducing the waste water generation to 43 kilolitres/day (after 1999) instead of 65 kilolitres/day from the paint shop.

Table 1

Controlling water pollution (in parts per million except pH)

	Gujarat Pollution Control Board's permissible limit	Actual	Before treatment
Total dissolved solids	2100.0	1994.00	2186.50
Chemical oxygen demand	100.0	55.00	96.50
Total suspended solids	100.0	34.00	51.00
Ammoniacal fluid	50.0	3.00	NA
Biological oxygen demand	30.0	13.00	60.00
Heavy metal	13.2	0.98	75.00
pH (6.5 to 8.5)	8.5	7.80	7.90
Sulphide	2.0	0.47	NA
Fluoride	1.5	1.49	3.55
Phenolic compounds	1.0	0.36	NA

NA – not applicable

Hazardous waste disposal initiative

The GMI has installed a sludge drying bed to reduce hazardous solid waste by over 25% by weight, by removing moisture content. The hazardous waste is disposed of at a common secured landfill. The paint shop phosphate sludge and incinerator ash is disposed of in lined and sealed HDPE (high density polyethylene) bags whereas ETP sludge is disposed of in encapsulated form through sealed RCC pipes.

Energy conservation initiative

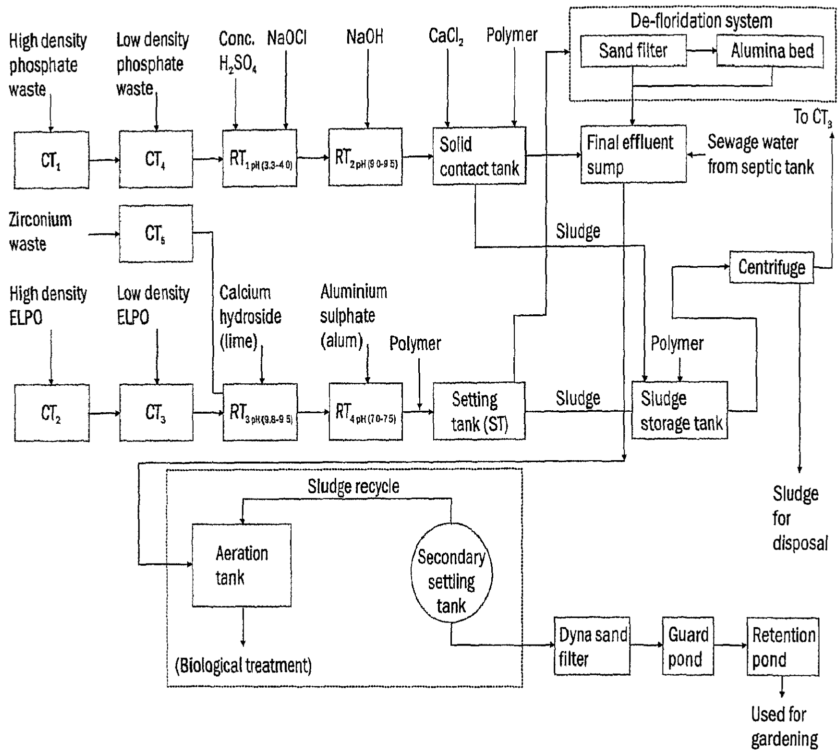
The GMI has implemented a formal energy conservation plan. The use of air cascading principle helps reduce air cooling/heating requirements in different seasons. The operation of switching on/off of the heating, ventilation, and air-conditioning system has been automated. All motors running below 80% load have been replaced. As a result of the above efforts, the electricity consumption per car produced came down from 1320 kWh in 2000 to 1183 kWh in August 2001, a saving of 10.4%.

Case study

The GMI has always laid stress on water conservation. From inception itself, the plant was designed for a complete closed water system in a way to completely treat and recycle trade effluent and completely treat and dispose of domestic sewage through a conventional septic tank and soak pit process. A modern ETP, with a high level of automation, was installed in 1995/96 and a storage tank of capacity 1300 m^3 was installed for retaining the treated waste water. All the necessary piping and water sprinkler systems were installed so that the plant was a zero discharge facility right from the beginning.

Subsequent measures like introduction of a closed loop DI (deionized) water circulation system helped save 20 kilolitres water per day; a modified phosphating process reduced DI water consumption by more than 10 kilolitres/day; installation of Magnazen minimized cooling blow-down and saved 24 kilolitres/day.

With the domestic waste water being as much as the trade effluent, in 2001 the GMI adopted an innovative approach for 100% recycling of modified sewage water. After evaluation of various treatments, it concluded that a joint treatment for trade and domestic effluent would be the best techno-economic solution. It provided anaerobic treatment to domestic waste water in the same septic tank for major sludge removal, and transferred the supernatant to ETP to mix with primarily treated common stream of trade effluents in the final effluent sump.



Flow diagram of effluent treatment system

Then the combined stream of effluent (trade and domestic) was provided with secondary biological treatment and tertiary treatment in the existing ETP facilities. The combined treated water is transferred to irrigation pond from where it goes for lawns/green belt development through the piping network. The management has laid down all the transfer pumps, long piping, cabling, control panel, instrumentation, and septic tank modifications for this facility.

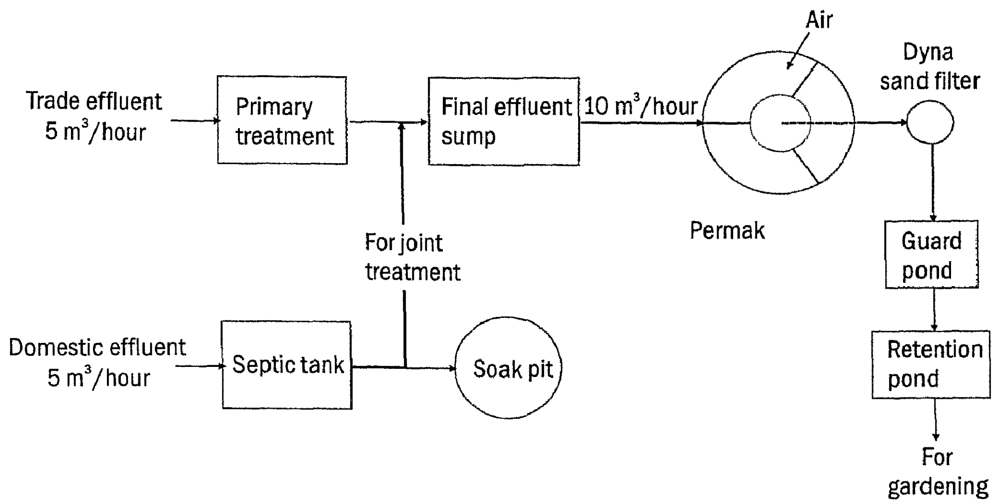
Primary chemical treatment is given to various streams to remove the heavy metals present in it. The primary treated waste streams are collected in a common final effluent sump and this common stream is given a secondary – biological – treatment. This removes/reduces biological oxygen demand and chemical oxygen demand load. Tertiary treatment to remove any residual solids, using the Dyna sand filter, is also provided. The filtered effluent is collected in the guard pond where it is tested and then pumped into the retention pond to be used for gardening and green belt development.

This modified sewage system has resulted in recycling of over 18 250 m^3 of water annually in addition to 15 000 m^3 due to trade effluent. The recurring cost savings achieved on account of reduced energy consumption associated with the use of recycled water was 69 400 rupees per annum.

The key drivers for programme adoption were a water shortage faced by the GMI for lawns/green belt development area, because of the vast area covered. Also, during summers, the yield from the tube wells was very low to almost nil. The company had to resort to buying water in some cases.

The approach adopted was to do a thorough treatablility and feasibility study to find out the best and most viable treatment system to modify the sewage/domestic waste water. The study was conducted by a professional environmental agency and on whose recommendations laboratory tests were conducted to put in a modified treatment process.

The main challenges faced were in terms of the timing of outlay for the programme, which coincided with a general recession in the company's business segment of premium cars.



.ow diagram

The payback period was kept to a minimum as the company used the services of a professional environmental agency, which recommended the course of action, after which the management approval was obtained for implementing this initiative. All the necessary facilities such as transfer pumps, long piping, cabling, and septic tank modification were set up later. Rigorous practical trials were done over 30 days to ascertain that the combined stream was getting the required treatment and that all the parameters were meeting the discharge standards.

The revenue generation potential of the project stems from the ease of transferability to other industries, which face a water shortage, as well as the non-prohibitive cost of implementation and quicker payback in terms of returns and lack of business interruptions.

Case study at a glance

The technical facets covered by the project are as follows.

- In 2001, the GMI (General Motors India) adopted an innovative approach for 100% recycling of modified sewage water. It concluded that a joint treatment for trade and domestic effluent would be the best techno-economic solution.
- It provided anaerobic treatment to domestic waste water in the same septic tank for major sludge removal, and transferred the supernatant to effluent treatment plant to mix with primarily treated common stream of trade effluents in the final effluent sump.
- Primary (chemical) treatment is given to various streams to remove the heavy metals present in it.
- The waste streams from primary treatment are collected in a common effluent sump for secondary (biological) treatment. This removes/reduces the load of biological and chemical oxygen demand.
- Tertiary treatment of effluent removes residual solids, using the dyna sand filter. The filtered effluent is collected in the guard pond where it is tested and then pumped into the retention pond to be used for gardening and green belt development.
- The combined treated water is transferred to irrigation pond and used for watering and green belt development through a network of pipes.
- Modification of the sewage system resulted in recycling of over 18 250 m^3 of water annually in addition to 15 000 m^3 of trade effluent.
- The recurring cost savings achieved on account of reduced energy consumption associated with the use of recycled water was 69 400 rupees per annum.

CASE STUDY

4 Indian Farmers Fertiliser Cooperative Ltd

Background

IFFCO (Indian Farmers Fertiliser Cooperative) Ltd, a multi-state cooperative society, is one of the world's largest manufacturers of fertilizers. Its membership extends to around 36 000 cooperative societies through which its products are channelized in 29 states and two union territories in India. It manufactures and markets 17.1% of nitrogenous and 17.7% of phosphatic fertilizers produced in India.

IFFCO has four fertilizer plants at Kalol and Kandla in Gujarat and Phulpur and Aonla in Uttar Pradesh and a country-wide marketing network for the distribution of fertilizers. IFFCO's Kandla plant produces complex phosphatic fertilizers (NPK and DAP) whilst all other units produce urea. IFFCO undertook its environmental project for total effluent recycle/reuse and zero effluent discharge at its Phulpur unit located in Uttar Pradesh. The unit has in operation, a single stream 1550 MT/day urea plant commissioned in 1980 and a twin stream 2 × 1293 MT/day urea plant commissioned in 1997.



A view of the plant at Phulpur, Uttar Pradesh

Environmental profile

The cooperative is environmentally conscious, responsible, and proactive. All the four manufacturing units are accredited with ISO 14001 and ISO 9002 certification whilst the marketing division is ISO 9002 certified. IFFCO's philosophy does not end with manufacture of fertilizer only—it has unstinted commitment towards the upliftment of the surrounding community also.

IFFCO has a well-defined environmental policy both at corporate and at unit level. All the four units of IFFCO have an elaborate set-up for monitoring SHE (safety, health, and environment) aspects on a day-to-day basis with highly qualified and trained specialists heading this department. Extensive efforts have been made for green belt development in all the four units and residential townships, including the protection of natural flora and fauna.



A view of green belt around the Phulpur factory

Waste management, natural resource conservation, environment protection, and its enrichment has always been of paramount importance to IFFCO Phulpur unit, which has adopted eco-friendly technology wherever possible. Due care is taken at the design stage itself, to select the best available technology that produces negligible waste, conserves resources, and reuses treated effluents to the maximum possible extent. 'Prevention is better than cure' has been the basis of the society's pollution control programme. Environment monitoring and control at IFFCO Phulpur is efficiently met by providing all necessary instrumentation and pollution control measures for effluents, emissions, domestic sewage, and solid wastes.

The cooperative has always undertaken agricultural extension and fertilizer use promotion programmes. Its balanced fertilization programme, adoption of villages for all-round socio-economic development, farmers' visits to various agricultural institutes and research farms, fields days, and crop seminars are all part of this effort. Other environmental programmes and special projects undertaken by the society under its corporate social responsibility programme include a farm forestry project (350 million rupees), drip irrigation project (7.5 million rupees), bio-fertilizers and bio-pesticides project (15 million rupees), and agricultural mechanisation project (7.5 million rupees).

IFFCO Phulpur unit has an independent environment and pollution control section headed by a senior executive under the direct control of a unit head. The unit has established and implemented environment management system as per ISO (International Organization for Standardization).

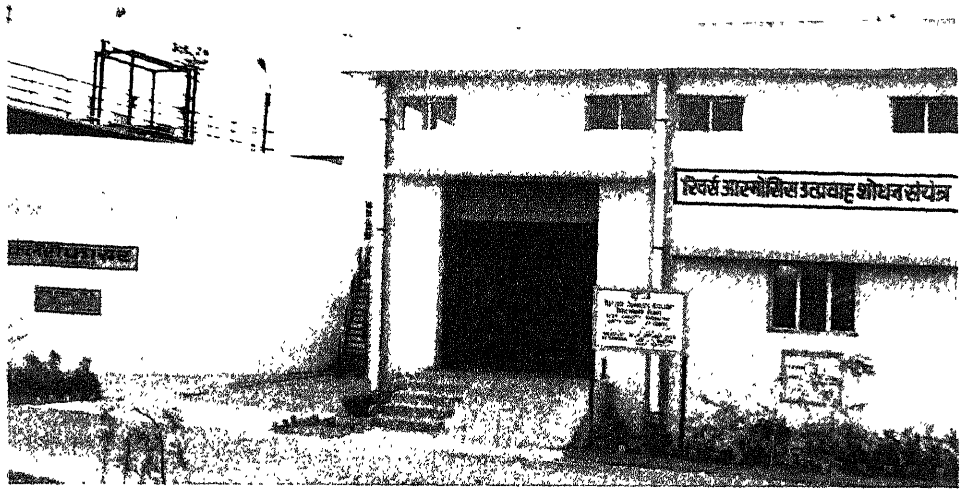
The main environmental programmes and initiatives taken by the unit are as follows.

Air emission initiative

The main air pollutants emitted in the flue gases are particulate matter (fly ash/urea dust), oxides of sulphur, and oxides of nitrogen. The unit has installed electrostatic precipitators, scrubbers for gaseous emissions, cyclone dust collectors, natural draft prill tower of substantial height, flare stacks, and chimneys of adequate height for steam generation units.

Effluent management

All the effluents generated from the various plants are subjected to extensive treatment to ensure that the treated water quality conforms to the specification laid down by the state pollution control board and MINAS (Minerals Accounting System). For effluent control, deep hydrolyser, distillation



Pretreatment system of reverse osmosis treatment-cum-recycle plant

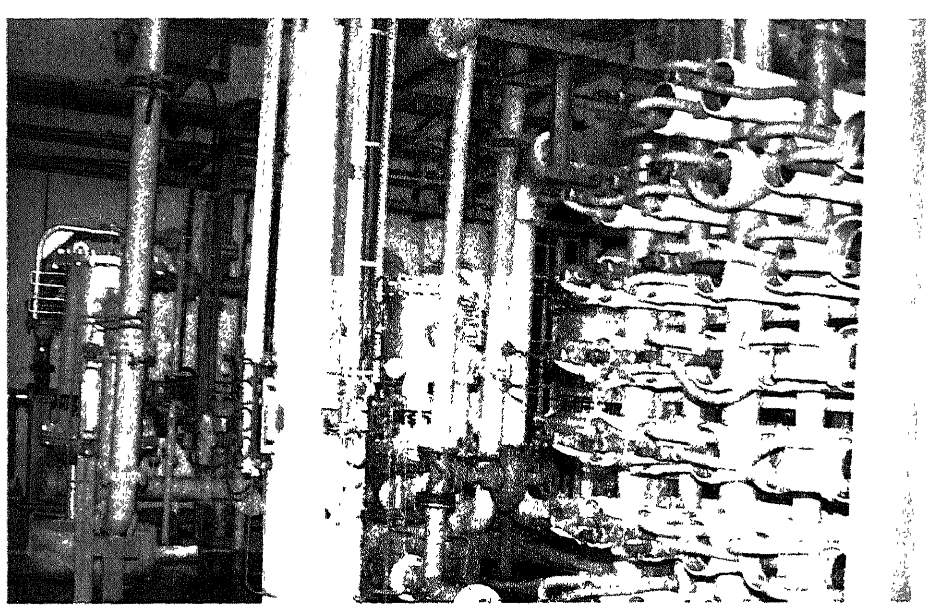
column, stripper, oil separator, treatment-cum-recycling plant on RO (reverse osmosis) technology, pH neutralization facility, guard ponds, etc. have been installed.

The unit has adopted a non-chromate cooling water treatment, which has completely eliminated the menace of hazardous heavy metals like chromium. It has implemented schemes to facilitate reuse/recycling of various effluent streams thereby reducing fresh water consumption to approximately 7.0 m^3/tonne of urea from 19.2 m^3/tonne of urea and achieving a zero effluent discharge from premises.

Management of hazardous and other solid wastes

The spent catalysts from the unit are stored securely in closed metallic drums and are then sold to parties who have authorization for eco-friendly hazardous waste handling.

IFFCO Phulpur has an elaborate system for solid waste handling and utilization. The fly ash generated is dispensed to cement industries in eco-friendly closed tankers, for which a dry ash collection system, i.e. the dense phase pneumatic conveying system, has been installed. During 2000/01, about 0.28 million tonnes of ash was utilized against generation of about



RO (reverse osmosis) membrane in RO treatment-cum-recycling plant

160 000 tonnes. The dried lime sludge generated in water softening plant is sold to outside parties to be used as binding material in fly ash brick pilot plants.

The unit has also undertaken a resource conservation initiative and substantial tree plantation under green belt development programme (50–200 m wide).

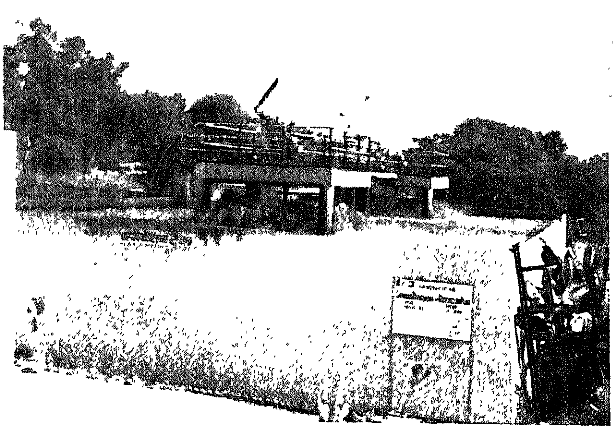
Case study

IFFCO Phulpur has always been very conscious and careful in utilization of effluent water. The unit adopted several water conservation schemes since inception for careful utilization of water. The unit also has a well-designed sewage treatment-cum-recycling plant comprising extended biological and physico-chemical treatment to treat and reuse domestic sewage water in the plant process. Between these two systems, the entire treated effluent generated in the factory is recycled/reused in plant process and irrigation and neither industrial effluents nor the domestic water are discharged from the premises.

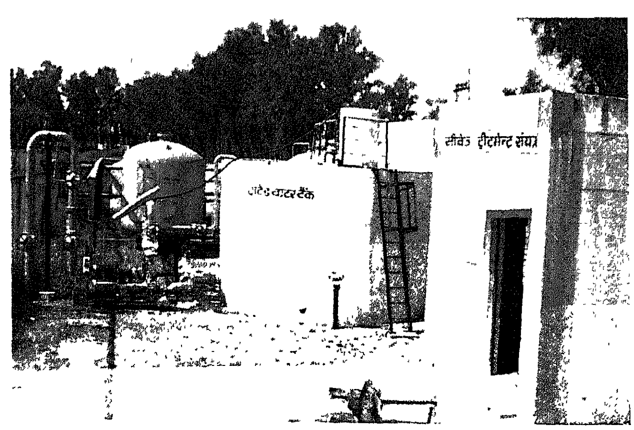
Water initiative

The effluent treatment and recycling plant is unique in the Indian fertiliser industry. The quench water/cooling water from inert gas plant (1200 m^3/day) is directly pumped to the water softening plant, thereby saving equal quantity of raw water. About 180 m^3/day of jacket cooling water of ammonia plant I is recycled into ammonia cooling tower as cooling water make-up. About 100 m^3/day of flash tank condensate, which comes out from power plant I, is also pumped into ammonia cooling tower as cooling water make-up. The total effluents are recycled through the RO effluent treatment plant.

After implementation of the above-said conservation measures (recycling/reuse of effluent water), the quantity of effluent generation reduced from original envisaged quantity of 17 990 m^3/day to 2400 m^3/day, i.e. a reduction of 15 590 m^3/day. The RO plant is designed to give 85% recovery of product water, which is then reused. This has led to a reduction in fresh water consumption to 7 m^3/tonne of urea from 19 m^3/tonne of urea over the last three years.



Aeration tank of sewage treatment-cum-recycle plant



Treated sewage water recycle system of sewage treatment-cum-recycle plant

Pollution prevention

The unit also installed a sewage treatment-cum-recycling plant for treatment and reuse of treated sewage water for process requirements instead of irrigation purposes. It also installed a dense phase conveying system for disposal of dry fly ash in eco-friendly closed tankers to cement plants and use of fly ash to reclaim soil.

Keeping in view the toxic nature of chromium and IFFCO's concern to minimize waste, it was decided to completely eliminate chromium from the cooling water treatment and adopt non-chromate cooling water treatment programme with effect from May 1997. Thus, use of chromium compound and the sludge it generates has been completely eliminated from IFFCO Phulpur complex. Sludge generation has been reduced from 8.15 tonnes (1996/97) to zero (1997/98 onwards).

The unit installed a sewage treatment plant at a cost of about 15 million rupees in 1997, to treat domestic sewage. The treated water of 2000 m^3/day is being recycled for plant process. The quality of treated water is monitored for pH, suspended solids, and bacterial counts. The treated sewage water is pumped to water softening plant and utilized as make-up water in the cooling towers. This sewage water is also utilized for irrigation of 61-hectare farmland of Moti Lal Nehru Farmers Training Institute, Phulpur.

In order to recover the valuable urea and ammonia from effluents and make the effluents reusable, a deep urea hydrolyser (operating at 240 °C) was installed. The hydrolyser system hydrolyses the urea present in waste water and recycles the products of hydrolysis, that is ammonia and carbon dioxide, back to process for increased production of urea. This water is purified for reuse as boiler feedwater after passing through condensate polishing unit.

To reduce the fugitive emissions, vent scrubbers have been provided at appropriate places. After installation of these scrubbers, the work environment has improved considerably.

To prevent oil pollution, disc oil separators and gravity oil separators have been installed in the urea and ammonia plants. These separators catch oil from the waste water for its safe disposal/reuse.

The dry sludge generated from domestic sewage treatment plant is used as manure. For continuous monitoring of effluent, a modern ammonia–urea analyser has been installed.

The key drivers for programme adoption were a concern for the scarce natural resource – water – and an overall concern for the environment. The fact that the unit had access to the best technology from Hydranautics, California, USA (which is one of the pioneers of RO), was another driving factor behind the initiative. The plant has been set up by Ion Exchange (India) Ltd at a cost of 88 million rupees.

The economic benefit of these schemes was not taken into consideration at the time of implementation. The main stress was on resource conservation, reducing environmental impact, and pollution abatement. The cost–benefit analysis of some of the schemes is given in Table 1.

The revenue rationale of the projects lay in the easy adoption of the technologies by other industries. Several industries and institutions have benefited by taking technical know-how and the unit's experience on reuse of recycled water.

Table 1 Cost-benefit analysis of some schemes

Cost-benefit ratio in terms of pay

Scheme implemented	*Year of installation*	*Saving of natural resources (m^3/day)*	*Expenditure (million rupees)*	*Payback period (years)*
Urea plant				
▪ Urea hydrolyser with online continuous urea ammonia analysis	November 1990	750	19.53	1.95
▪ Process condensate and steam condensate recycle (replaces demineralized water which is used for steam generation)	October 1990	1700	1.79	Less than a year
Ammonia plant				
Process condensate recycle to steam generation plant	October 1980	1200	7.30	2.60
Inert gas plant				
Inert gas plant effluent is reused in de-ashing/ water softening plant (replaces raw water)	February 1988	1200	1.20	3.03
Total effluent recycle system at guard pond outlet system				
Effluent water is recycled and reused for de-ashing, irrigation of farm land, coal yard spraying, ash pond spraying and green belt development (replaces raw water)	May 1990 to February 1996	9770	14.80	4.36
Sewage treatment plant				
Treated sewage water is recycled into softening plant (replaces raw water)	August 1997	2000	15.10	No payback

Case study at a glance

The various initiatives/schemes implemented at IFFCO Phulpur have had encouraging results.

- After implementation of conservation measures (recycling/reuse of effluent water), the quantity of effluent generation reduced from original envisaged quantity of 17 990 m^3/day to 2400 m^3/day, i.e. a reduction of 15 590 m^3/day. The rest of the effluent was recycled as cooling water make-up after RO (reverse osmosis) treatment.
- As per environmental norms, the prescribed standard of effluent generation for straight nitrogenous fertilizer plants is 5 m^3/tonne of urea. The in-plant recycle system at IFFCO has been able to reduce effluent to 2.09 m^3/tonne for Unit I and 1.87 m^3/tonne for Unit II—both far below the norm.
- The entire effluent generated in the factory is recycled/reused after adequate treatment in plant process and irrigation. Thus, neither the industrial effluent nor the domestic sewage water is discharged from the premises, thereby reducing the pollution load in the surrounding environment.
- As per the state pollution control board, IFFCO is allowed to discharge 9600 m^3/day from Unit I and 5400 m^3/day from Unit II of effluents from the premises, which has been reduced to zero.
- The ammonia content in the effluent has been reduced to 20 PPM (parts per million) as compared to 50 PPM norm fixed by statutory authorities.
- Reuse of treated water prevents the unit from drawing equivalent quantity of groundwater. This helps in maintaining groundwater strata in its natural form.
- The waste water is used for irrigation of green belt developed in usar (alkaline) soil. The continuous use of this effluent water changes the alkaline characteristics of soil over time. So use of this water gives twin benefits: one 'usar' reclamation and the other its use as irrigation water.
- About 5 tonne of waste sludge is generated per month in the sewage treatment plant. This is used as manure in farmland and for horticulture.

CASE STUDY

5 Mangalore Refinery and Petrochemicals Ltd

Background

The MRPL (Mangalore Refinery and Petrochemicals Ltd), a joint venture refinery of the Hindustan Petroleum Corporation Ltd and the AV Birla group of companies, manufactures liquefied petroleum gas, motor spirit, kerosene, aviation turbine fuel, diesel, naphtha, bitumen, and sulphur.

The company has a refinery on the outskirts of Mangalore city, in the Dakshina Kannada district of Karnataka. The refinery was commissioned in two phases. Phase I of the refinery of 3 million tonnes per annum was commissioned in March 1996 and Phase II of 6 million tonnes per annum was commissioned in September 1999. It is here that the company has undertaken the environmental project for reduction of chemical sludge and reuse of recycled effluent refinery water.

Environmental profile

The company is environmentally committed and seeks to create an awareness and respect for the environment through healthy operating practices and employee involvement in environmental improvement. It is committed to bringing about environmental improvement by adopting eco-friendly techniques/processes for optimal energy use and reduction of hazardous emissions and wastes.

Between 1998 and 2001, the MRPL has undertaken a number of environmental initiatives at an investment of 36 million rupees. These have led to energy savings of 135.7 million rupees on an annual basis. The MRPL believes in going beyond the compliance benchmarks and has in place abatement measures for air and water pollution. It also has a management programme for hazardous wastes, which are generated from the refinery, and has undertaken major energy and water conservation initiatives.

The company has in place a clearly defined environment policy for air, water, and hazardous waste handling, storage, and disposal. It has sought to reduce environmental pollution through better systems, technologies, and raw materials on the one hand, better quality end products, on the other. The company has undertaken major environmental initiatives like installation of a sulphur recovery unit (at a cost of 2 billion rupees), an amine treatment unit, and a sour water stripping and flare system to minimize the emissions of SO_2 (sulphur dioxide) into the atmosphere.

The MRPL has in place advanced monitoring systems. Continuous online SO_2, NO_x (oxides of nitrogen), and CO (carbon monoxide) analysers are fitted to all fired stacks for online monitoring. The fuel gas generated in the refinery is fully utilized in the heaters located in the refinery.

The MRPL has efficient waste water treatment plants, which treat the refinery effluents to the quality specified by the State Pollution Control Board. Due to the innovative use of hydrogen peroxide as the main oxidant for removal of sulphides and phenols from treated effluent, the MRPL is able to recycle 70%–75% of the treated effluents in the cooling towers.

Round-the-clock monitoring of the waste water treatment plants is done so as to ensure that the quality of treated effluents is far lesser than the standards stipulated by the Karnataka State Pollution Control Board.

The oil and chemical sludge generated is treated in thickeners and centrifuges, and is stored in impervious sludge lagoons, constructed using geosynthetics. These are then left for biodegradation, after which they are permanently filled in secured landfills so as to avoid groundwater contamination. The garbage and non-refining wastes are filled in the impervious sludge lagoons and the biodegraded sludge is used as compost/manure.

Case study

During the last five and a half years, the MRPL adopted an innovative change in the waste water treatment methodology to reduce sludge generation. In the last three years, the company has further improved upon the same so that it can reuse 70%–75% of the treated effluents for its cooling towers.

Reduction in sludge initiative

Instead of using the original effluent treatment design in which sulphides are treated using $FeSO_4$ (ferrous sulphate), NaOH (sodium hydroxide), and chlorine, thereby generating 32 tonnes/day of sludge, the MRPL experimented with other oxidizing agents in place of $FeSO_4$ and chlorine to remove sulphides. The oxidation was not found to be effective, chlorine oxidation (without $FeSO_4$) did not work, and ozone was found to be too costly.

A trial with H_2O_2 (hydrogen peroxide) established that sulphides can be directly oxidized to sulphates, which are soluble and do not leave a precipitated sludge. After many trials, a relationship between pH and H_2O_2 dosage was established. It was found that all sulphides could be oxidized, at a certain pH, to sulphates, which would be in solution with no formation of sludge/precipitate.

By way of innovative adoption of H_2O_2 treatment technology in waste water treatment, the MRPL reduced sludge generation from 32 tonnes per day to 2 tonnes per day. The MRPL then installed an H_2O_2 storage tank, dosing pumps, pH analyser, and all other safety facilities for permanent H_2O_2 dosing.

Reuse initiative

As the actual water quality from the waste water treatment plant turned out to be better than the stipulated norms, the MRPL explored the possibility of reusing treated effluent on a continuous basis. Of the various uses examined, use in the cooling towers to partly replace fresh water make-up was found to be most effective. In the circulating cooling water system, part of the water is lost in evaporation. This warrants continuous make-up in terms of fresh water. However, before the treated effluent could be used in the cooling tower it had to be cleansed of traces of oil, sulphide, and phenol. The MRPL selected a suitable supplier of cooling water treatment chemicals for initiating the required chemical treatment system.

Reuse of treated waste water was started in 1997. Additional active carbon filters were installed on treated waste water before feeding it into the cooling tower. Gradually, the recycled quantity of treated waste water was increased from 10% to over 70%. This saved 160 m^3/hour of fresh water from the river. It also reduced treated waste water going into the sea by 70%.

The technological advantages of H_2O_2 dosing over the conventional technologies are as follows.

- Reduced sludge generation from 32 tonnes per day to 2 tonnes per day
- Very good dissolved oxygen in treated waste water
- Easy monitoring of H_2O_2 dosage
- Low maintenance on sludge pumps, thickener, and centrifuge
- Conventional chlorinated treatment increases salt in the treated effluents, which limits their reuse in cooling towers. H_2O_2 as an oxidant prevents this and enhances reuse of effluents in cooling towers.

The significant environmental benefits of the programme include

- avoidance of groundwater contamination through reduction in sludge generation;
- conservation of land, which is a precious limited resource, as lower sludge generation results in a lower land requirement for landfills;
- resource conservation through better recovery from raw materials as production of large quantity of sludge creates wastage of hydrocarbons attached with it, which otherwise can be processed in the refinery;
- resource conservation in terms of replacement of 160 m^3/hour of fresh water by treated waste water for use in the cooling towers; and
- usage of 70%–75% of the treated effluents in cooling towers.

Other than the significant environmental benefits of the project, the key drivers for programme adoption were the availability of in-house R&D support and a growing concern regarding the high energy costs, time costs and maintenance expenditures the company would have had to incur to deal with the vast quantities of hazardous sludge generated through the use of the old technology. Also sludge $Fe(OH)_3$ is not biodegradable and would cause disposal and storage problems.

The approach adopted by the MRPL was to start with laboratory tests followed by field trials and then the construction of a full-fledged permanent facility for H_2O_2 dosing. The company conducted field trials to establish the optimal relationship between pH and H_2O_2 dosage.

The main challenges faced during the implementation of the project were the evaluation and implementation of alternative technologies for oxidation of sludge so as to find the best possible techno-economic solution. H_2O_2 oxidation technology was found to be economically attractive as, due to reduced sludge generation, precious land area of approximately 20 acres is saved, which would have otherwise been utilized for sludge storage. Also attention on maintenance in the waste water treatment plant was reduced considerably.

The revenue generation potential of the project results from the sale of this technology to other petroleum and allied industries.

An important environmental payback for the industry as a whole is the development of a new cost-effective technology for the reduction of sludge from a refinery and the reuse of treated waste water in cooling towers thereby easing pressure on the reservoirs of raw water in the region and reducing the risk of groundwater contamination.

Case study at a glance

The MRPL (Mangalore Refinery and Petrochemicals Ltd) has taken a number of environmental initiatives at a cost of 36 million rupees. These include initiatives for reducing air pollution and hazardous waste (sludge), and reuse of waste water. To tackle the latter two problems, the company

- substituted conventional oxidants used in treatment of sludge with hydrogen peroxide, and
- set up a waste water treatment plant.

This resulted in (a) a low level of sludge generation, which came down from 32 tonnes per day to 2 tonnes per day in five years, and (2) recycling of treated effluent in cooling towers, which led to a saving of 70% of the fresh water required for cooling.

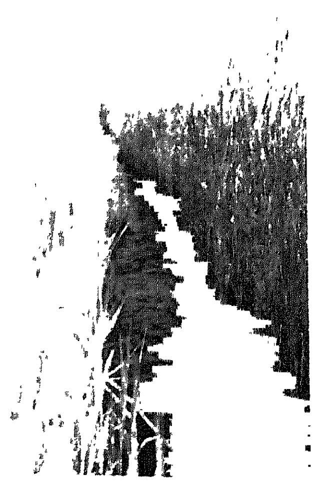
Key environmental initiatives

Some of the key environmental initiatives include attaining ISO 14001 certification, achieving zero discharge level of coloured effluent into river Sone through the HRTS (high rate transpiration system) during summer months, and farm forestry programme since 1986 to increase the green cover in 14 districts of Madhya Pradesh.

Case study

The paper manufacturing process requires a lot of water. Most of it comes out as industrial waste water. The main water pollutants are the effluents from the paper machine, pulp mill, soda recovery unit, and the power house. The mill takes stringent measures to mitigate water pollution. The effluent generated has to undergo a thorough treatment, which ensures that parameters like pH, biological oxygen demand, chemical oxygen demand, and suspended solids are well within the pollution standard norms. These parameters are monitored daily.

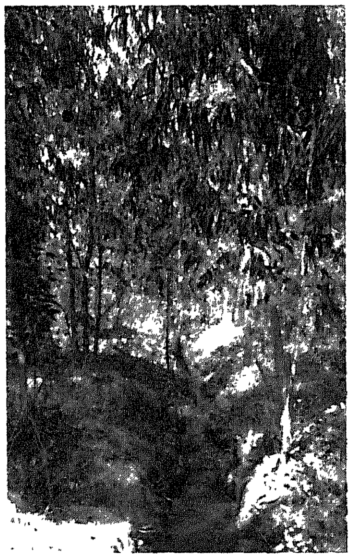
About half of the waste water is coloured due to sodium lignin compounds that are difficult to degrade after treatment. At OPM, even though this treated coloured waste water met all statutory parameters, it was causing aesthetic pollution of the river. To reduce the volume of coloured waste water going into the surface water, the OPM in collaboration with NEERI (National Environmental Engineering Research Institute), Nagpur, carried out extensive research to find alternative uses of this coloured effluent. Their research showed that treated waste water can be successfully used as irrigation water for many agricultural and forestry crops in light textured soils. Based on this research, NEERI developed an HRTS, a land treatment technology, for utilization of pulp and paper mills' waste water. The HRTS is a unique land treatment system, which uses dynamic, multi-component soil system as a filtration device to clean the waste water. The soil system works in conjunction with plants on it that act like a bio-pump through their high transpiration capacity.



Paddy cultivation under Grade III irrigation during kharif season of the year 2000

For developing the HRTS technology, the initial research was conducted with lysimeters in a controlled environment to assess the potential evapo-transpiration from the soil. The lysimeter study helped in assessing the total area required for complete utilization of the fully treated coloured waste water. In the next stage, research was conducted to identify the tree species that could tolerate fully treated waste water loading and at the same time increase transpiration from their stomatal network. Research was also conducted to assess the result of change in wood characteristic in the HRTS network. There have been differences in the field due to different evapo-transpiration conditions, which are being incorporated, in the second phase of HRTS expansion. Identification of suitable species with higher transpiration was an important finding of the research, and tree and grass species were selected accordingly.

This land treatment system has provided a cost-effective and environment-friendly solution to the problem of managing coloured waste water at the mills. In the first phase (1994–97), the HRTS was developed on 80 hectares of land within the mill's premises. It utilized 30%–75% of the



Eucalyptus plantation under HRTS

coloured waste water generated from the mill depending upon evapo-transpiration conditions. In the second phase (1999–2002), the HRTS was expanded to 150 hectares of land for full utilization of coloured waste water and has achieved zero discharge of Grade III effluent.

The programme is being implemented by an environment management committee with close cooperation of the civil engineering department for initial development and the raw material development department for planting of suitable tree species. The R&D division of the mills is responsible for the daily monitoring of the programme. The mills have also been getting the effluent treatment plant and the HRTS monitored by Regional Research Laboratory, Bhopal, and the Central Pulp and Paper Research Institute, Saharanpur.

The OPM is now planning HRTS development with community participation. It has promoted formation of village forest committees in nearby villages and has taken up social forestry projects irrigated with fully treated waste water. The OPM will provide superior quality planting stocks along with technical guidance for development of these forests. The produce of these forests will belong to the community for which OPM will provide a buyback assurance.

The initial investment is high due to large land requirement, developing them as HRTS, and planting and irrigation systems in the area. But the system is economical in the long run as after the initial stage only application, maintenance, and monitoring costs are involved.

The local community has benefited a lot from the programme. The farmers adjacent to the mills have started planting two crops in a year instead of one because of their reduced dependence on seasonal rain. The development of forests has provided the local community with employment opportunities and forest produce for consumption and income generation. Also, rejuvenation of the river has benefited the community living downstream.

Case study at a glance

- The Orient Paper Mills has promoted social forestry in the neighbouring community.
- The company has achieved zero discharge of Grade III effluent.
- The mill has, through its high rate transpiration system, reduced colour in water to the minimal level.
- Treated waste water is made available to the farmers, who use it to grow two crops instead of one, since they are less dependent on rainwater.

Reuse of old packing

The company has tied up with the scrap dealers to buy back their funnel packing, which they reuse three to four times, thereby saving natural resources utilized in packing. The reuse of packing material has increased from 1.5 cycles to 2.5 cycles.

Abrasive sludge recycling

The abrasive sludge, which results from the pumice and rouge powder used in the black and white finishing operation, is dried and reused. Due to this recycling, the pumice powder consumption per panel has reduced from 66.5 gram to 56 gram per panel polishing.

Asbestos elimination

In order to avoid the usage of asbestos in hot ware handling pads, hot ware conveying belts, conveying racks in the sealing plant, and cushion covers in preheating hangers, the company along with outside agencies worked at replacing asbestos with fabrics that could resist high temperatures. Finally, asbestos was replaced by Kevelor material, glass wool, and other Kevelor-based material.

Cerium elimination

The company has eliminated hazardous radioactive cerium material used in the batch composition for reduction of browning effect in the panel glass. Through the application of voltage and browning co-relation, the company's glass team was able to experiment and establish that even without cerium, with a slight modification of batch composition, the same results could be achieved.

Ground glass recycling

The ground glass, which is a result of the cutting and grinding of the seal edge material and subsequent polishing of the seal edge, is dried up to a moisture of less than one per cent and is recycled in the batch house.

Fly glass conversion

In order to reduce the wastage of water and other natural resources, and improve the safety of the changeover from black and white glass bulbs to colour glass bulbs, the company's glass conversion team formulated an alternative changeover process based on 'on the fly' conversion method. This method, where the new glass composition is fed in slowly and simultaneously the old glass composition is taken out slowly, has eliminated the wastage of water by 70 kilolitre per hour and natural gas by appoximately 30 000 cubic metres per day for 10 days.

Case study

During the last three years, a programme involving a capital expenditure of more than 10 million rupees was undertaken involving the implementation of the zero discharge programme. The main objectives of the programme were to reduce waste generation from batch waste, chrome water, and waste oil. The environmental programme was made on these objectives and targets and these were reviewed and monitored periodically. When the target was achieved, then it was further tightened. The main initiatives undertaken in the programme are given below.

Water conservation and effluent treatment initiative

The company has a close loop water plant for abrasive, cullet, and chrome water treatment. This means that all the water used in the above activities is treated and is then reused so that there is no water discharge from these plants.

The company set-up a new waste water plant, which was designed to produce deionized water from treated effluent. The waste water was converted into deionized water using reverse osmosis. The plant design and slurry systems (built up in the project) were further improved to achieve lead content of less than 0.1 PPM (part per million). This system was then further modified to make use of treated water for on-site irrigation as well as for making reagent/dosing solutions.

The plant design includes four sections—the ETP (effluent treatment plant), the UF (ultra-filtration) plant, the RO (reverse osmosis), and the deionization sections. The raw effluent from the plant is pumped into the ETP area, from where it is taken to a thickener tank. Here sufficient detention time is given, so as to settle the heavy particles. The tank has a sludge scraper mechanism from where the water is taken to the equalization tank. Supernatant from the tank is taken to the equalization tank, which is provided with a number of blowers and an air grid mechanism to avoid any settling of suspended matter. Effluents from the equalization tank are fed into an HRSC (high rate solids classifier) wherein colloidal particles are settled. Lime and Fe_3SO_4 and polymer are dosed to aid the settling process. The water is then treated in the pH correction tank, where acid is dosed to maintain the effluent pH in the neutral range. The backwash water from the filter is re-circulated to the equalization tank and the sludge from the thickener and HRSC are pumped into the sludge drying beds.

The treated effluent, free of organic particles, is then pumped into the UF plant where fine colloidal particles are removed. This water is then pumped into RO membranes, which separate the dissolved solids. The rejected effluent from RO systems is fed into another RO system to recover more water. The final concentrate from the reject RO system is then led to the central trade effluent pit. The water is passed through the degasser system to remove excess carbon dioxide.

Abrasive water treatment plant

The abrasive water treatment plant treats the water that comes from the area where the glass shells are polished to provide a smooth surface. The treatment plant has an equalized tank, coagulation tank, settling tank/clarifier, sludge drying beds, and treated water tank. The untreated water is processed and used in the process again, leading to zero discharge from the plant.

Cullet water treatment plant

The cullet water treatment plant treats water used for glass quenching, which carries fine glass pieces. After the equalization tank, the water is pumped on the screen and large glass pieces are separated. The oil from the lubrication system is skimmed by using belt/disc skimmers. The water is then stored in a tank and is reused in the same process.

Chrome water treatment plant

The chrome water treatment plant treats water coming from the mould shop. The process includes equalization, reduction, neutralization, flocculation, and sedimentation. The treated water is then used in gardening.

Sewage water treatment initiative

The treated water is stored in a separate tank and is then used for gardening. The company has also installed a piping network to use treated sanitary water for gardening purposes within the premises. The remaining sludge is also used in the garden. In 2000, the plant was upgraded by improving the aeration system, adding a sludge settling system and a disinfection system.

Through this, the company could achieve a BOD (biochemical oxygen demand) 10 mg/litre, which is a world benchmark, as compared to the Indian acceptable standard of BOD 30 mg/litre.

The key drivers for programme adoption were a need for the company to reduce process water consumption from 8741 kilolitres/month (1997/98) to 4955 kilolitres/month (1999/2000) as well as conserve water and reduce pollution.

The approach adopted was to design a new water treatment plant with the provision to produce deionized water from treated effluent through the use of RO. The company also received inputs from Corning Incorporated, USA, and took the help of the environment management division of the Confederation of Indian Industry for design and implementation of the EMS.

The revenue generation potential of the initiative lies in its easy adoptability by other players in the same line. The company has published and circulated its experience to its other units, some of which have started working on the same. From the techno-economic as well as administrative point of view, the transferability of the water conservation programme is good.

The measurable payback for the project has been in the form of reduction of pollution and conservation of water resources from the plant. Some of the environmental benefits of the project are listed below.

- The zero discharge project has resulted in water standards, which are beyond compliance. As against the permissible treated water discharge of 480 kilolitres/day, allowed by the state pollution control board, the plant is not discharging any treated water.
- There has been a reduction in process water consumption from 8741 kilolitres/month in 1997/98 to 4955 kilolitres/month in 1999/2000. After the implementation of the colour funnel in October 2000, the target was revised to 135 000 kilolitres/month, which the company achieved in January 2001. The new target is 11 500 kilolitres/month.
- The domestic water consumption has come down from 455 kilolitres per day in 1996/97 to 70 kilolitres per day in 1999/2000.
- The company could achieve a BOD level of 10 mg/litre in sanitary effluents, which is a world bench-mark, as compared with the Indian allowable standard limit of 30 mg/litre.
- Treated sanitary water is used for gardening purposes, thereby conserving the raw water.
- Treated water, which has a lead content of less than 0.1 PPM, is used for on site irrigation and also for making reagent/dosing solutions.
- The intangible but very important environmental benefit for the region as a whole has been the increase in the level of water table due to conservation of water as well as due to the development of the water harvesting pond. The company also provides the technical know-how in water harvesting to other companies.

Case study at a glance

Samcor Glass Ltd has invested 10 million rupees in the last three years in environmental management.

Technical facets covered by the project include the following.

- Use of a close loop water plant for abrasive cullet and chrome water treatment. This means that all the water used in the above activities is treated and reused so that there is no water discharge from these plants.
- Implementation of a new waste water plant designed to produce deionized water from treated effluent. The waste water was converted into raw water using reverse osmosis.
- The plant design and slurry systems (built up in the project) were further improved to achieve lead content of less than 0.1 part per million. This system was then further modified to make use of treated water for on-site irrigation as well as for making reagent/ dosing solutions.
- The plant design includes four sections—the effluent treatment plant, the ultra-filtration plant, reverse osmosis, and the deionization section.
- A new sludge treatment plant with an improved aeration system through which the company could achieve a BOD (biochemical oxygen demand) level of 10 mg/litre, which is a world benchmark, and also compares well with the Indian acceptable standard of BOD 30 mg/litre.

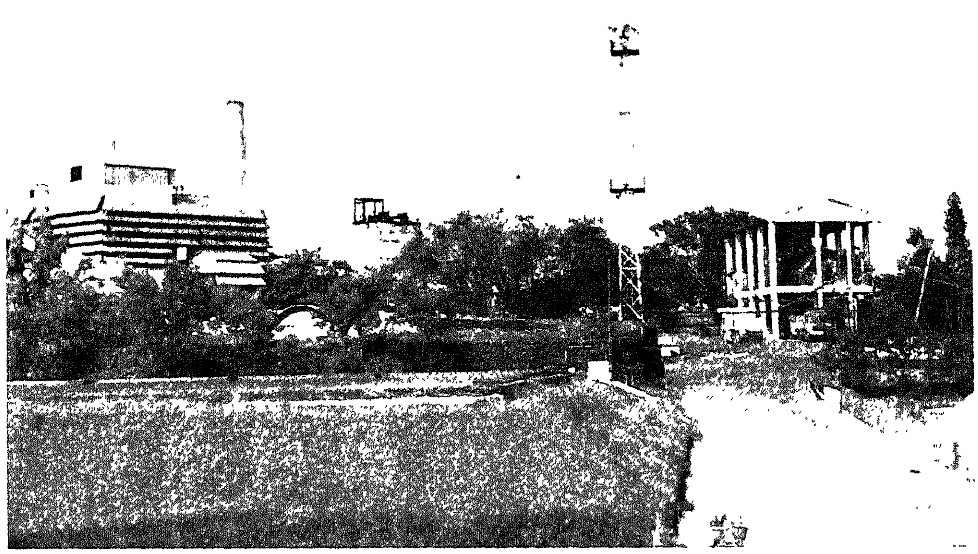
CASE STUDY

8 Seshasayee Paper and Boards Ltd

Background

The SPBL (Seshasayee Paper and Boards Ltd), an integrated pulp and paper mill, incorporated in 1960 with an initial installed capacity of 20 000 tonnes of paper and paperboards per annum, is located near Erode in Tamil Nadu. Over the years, the SPBL has expanded its capacity to 115 000 tonnes per annum. Today, the SPBL exports nearly 20% of its production to various countries. It has an annual turnover of 3500 million rupees and employs about 1600 persons. As a result of various expansion and modernization schemes carried out in different stages, the SPBL has a complex cluster of equipment with five paper machines to produce a wide range of fine papers such as printing and writing papers, posters, paperboards, packaging papers, copier paper, and coated boards. The SPBL has production facilities to produce both bleached wood and bagasse pulps and has a chemical recovery section. The utilities include power boilers, turbo-generators, water treatment plant, and an effluent treatment system.

The SPBL is one of the pioneers in using bagasse, a residue left after extraction of sugar from sugar cane, for the manufacture of paper. The SPBL promoted a captive sugar mill, namely Ponni Sugars (Erode) Ltd (formerly Ponni Sugars and Chemicals Ltd), to obtain sugar cane residue (bagasse) for making paper. As the surrounding comes under a rain-shadow area, it was dependent on the vagaries of monsoon. Hence, the SPBL implemented a well-conceived irrigation scheme, using its treated effluent. This arrangement resulted in conversion of large areas of dry and barren lands into wetlands, thus creating a vast green belt in the neighbourhood. This irrigation scheme has significantly improved the prosperity and the standard of living of local farming community.



The factory of Seshasayee Paper and Boards Ltd

Environmental profile

The SPBL is both an ISO 9001 and ISO 14001 company. Its environmental policy commits itself to manufacture quality papers in a clean, green, and safe environment; to continuously improve its environmental performance by reducing air emissions, process effluents and solid wastes; to optimize usage of resources like water, power, fuel, and raw materials; and to comply with relevant regulations. The company also has a safety policy to provide safe working environment, processes, and systems.

The main water pollutants at the plant are BOD (biochemical oxygen demand), COD (chemical oxygen demand), TSS (total suspended solids), TDS (total dissolved solids), and percent sodium. To minimize the pollution level, the SPBL has installed a primary effluent treatment system followed by a secondary biological effluent system. With regard to air pollution in the plant, mainly caused by suspended particulate matters such as sulphur dioxide and oxides of nitrogen, the company has complied with the prescribed parameters by putting in place electrostatic precipitators and cascade evaporators.

Hazardous wastes and solid wastes are either disposed of as raw materials to relevant units or reused for specific purposes in the plant. For example, cinder and fly ash are used to manufacture compressed bricks and hollow blocks whereas sawdust and pith are burnt as fuel in power boilers.

In order to reduce the consumption of natural fossil fuels, one of the power boilers has been retrofitted to use bio-fuels like coconut oil, bagasse pith, sawdust, etc. Water consumption in the plant has also been significantly reduced through a system where the back water is treated and reused.

SPBL has installed alkali recovery pits at strategic points within the mill for trapping the alkali, if any, that may otherwise escape and find its way to the effluent drain. By this, the dual objectives of saving the chemicals as well as improving the quality of effluent are achieved.

The company has received many awards and recognition in the areas of environment conservation and pollution control, export performance, energy conservation, productivity and capacity utilization, safety, and cordial industrial relations.

The list includes awards from FICCI (Federation of Indian Chambers of Commerce and Industry) in 1993/94, the Tamil Nadu Pollution Control Board in 1995/96, and TERI (Tata Energy Research Institute) in 2000/01.



The FICCI award being received from the then Hon'ble Prime Minister, Mr P V Narasimha Rao

Case study

The SPBL conceived of using treated effluent to irrigate dry land initially in 1983, even before the Government of India constituted its pollution control agency. The treated effluent is though well within the inland surface water discharge standards, the same is effectively utilized on land for irrigation purposes, thus creating a harmonious integration of paper mill, sugar mill, and the farming community.

Details of the irrigation scheme

Description	Area covered (in hectares)	Number of farmers in the area
Gravity flow	81	60
Odappalli Pappampalayam Lift Irrigation Society	223	223
Odappalli Mukkuparai Lift Irrigation Society	172	131
Kattur Lift Irrigation Society	162	45
Vellayankadu Lift Irrigation Society	16	22

This irrigation scheme, financed by the Bank of India and the National Bank for Agriculture and Rural Development, has been implemented with a visionary approach that yielded many advantages.

- *Enhancement in sugar cane yield* Sugar cane yield is higher by 10%–15% in the fields irrigated with treated paper mill effluent compared to that of fresh water irrigation.
- *Colour reduction in effluent* The treated effluent percolating from the fields after being used for irrigation is void of colour and rich in dissolved oxygen as the soil acts as a good colour-removing medium.
- *Increase in active surface of soil* The organic matter present in the paper mill effluent promotes a granular structure, which, in turn, permits soil to hold more of both water and air. In other words, the organic matter tremendously increases the amount of active surface in each square inch of soil.



View of a field irrigated with treated effluent

- *People's goodwill* The SPBL credits the success of this irrigation scheme to the involvement of local farmers for whom it is the 'lifeline'. There is improvement in their sugar cane yield, agricultural income, standard of living, employment opportunities for farm labour, and their morale. They now have a ready market for their produce. The company provides technical guidance and community development schemes and holds periodical redressal meetings with local farmers.
- *Evolution of a closed circuit system* The entire treated effluent of the company is utilized for irrigation for cultivating sugar cane, which is supplied to Ponni Sugars, who in turn, release the entire bagasse to the SPBL for paper manufacturing. This irrigation scheme thus not only enables the company to avoid effluent discharge into the river, but also paves the way for a completely closed circuit system that is sustainable in the long run.
- *Using bagasse* The SPBL installed fossil-fuel-fired boilers in Ponni Sugars to ensure utilization of bagasse for paper manufacturing. Use of bagasse contributes to preservation of environment and maintenance of ecological balance since about 3.7 tonnes of wood are left uncut for every 6 tonnes of bagasse used for paper manufacturing.
- *Reduction of alkali load* Alkali load is reduced due to higher use of bagasse in paper manufacturing and consequential reduction in the use of cooking chemicals.

The TNAU (Tamil Nadu Agricultural University), Coimbatore, is entrusted with the task of finding the effect of sustained use of treated paper mill effluent on soil characteristics.

Further monitoring of soil and groundwater in the coverage area of the irrigation scheme is being carried out by the TNAU, under an endowment scheme.



A drinking water tap provided by Seshasayee Paper and Boards Ltd

Case study at a glance

The SPBL (Seshasayee Paper and Boards Ltd) has conceived a unique irrigation scheme. This innovative scheme has brought vast areas of dry lands under irrigation using treated effluent for raising sugar cane. The key to the successful implementation of this scheme has been the harmonious integration of the paper mill, the sugar mill, and the farming community. In order to make the scheme successful and beneficial to all, the SPBL took the following steps.

- Involving local farmers and motivating them to use treated effluent for growing sugar cane
- Mutually beneficial relationship between sugar and paper industry
- Technical guidance such as crop rotation, soil management, pest management, yield improvement, etc. for local farmers
- Involvement of government authorities in promoting this irrigation scheme
- Periodical redressal meetings with farmers
- Installation of high density polyethylene pipeline network to avoid pilferage of treated effluent
- Installation of drinking water pipeline network in the neighbouring villages.

CASE STUDY

9 Shriram Fertilisers & Chemicals

Background

DCM Shriram Consolidated Ltd, part of the Bharat Ram group, manufactures and markets urea fertilizer, PVC resins and compounds, caustic soda, chlorine and chlorine chemicals, calcium carbide, cement, sugar, and textile yarn. It also markets hybrid seeds, pesticides, DAP (di-ammonium phosphate), and MOP (muriate of potash) fertilizers. The company also provides services in the field of energy conservation and environmental management. It is multi-locational and has its manufacturing bases at Kota and Tonk in Rajasthan, Bharuch in Gujarat, and Shahjahanpur in Uttar Pradesh. The Kota unit contributes the majority (about 90% in 2000/01) of the turnover. It is here that the company has undertaken its environmental project.

Environmental profile

The company is environmentally conscious, responsible, and proactive. The SFC (Shriram Fertilisers & Chemicals) plant at Kota has been trying to minimize pollution in its vicinity.

The Kota plant has well-defined environmental policies and all units are ISO 14000 compliant. The management has committed itself to taking measures for controlling pollution and to undertake large-scale tree plantation. Today, there are over 230 000 trees in the green belt at SFC, Kota, which also has an EMS (environment management system) in place. A management representative ensures smooth functioning of the EMS in all four units of the plant. The head of each department or plant is responsible for implementation of environment management programmes and operational control procedures. A centralized environment and pollution control department, headed by a senior manager, looks after statutory compliance, coordinates with government agencies, and monitors environmental control equipment.

By investing 300 million rupees in pollution control equipment over the last 15 years, the SFC's commitment to improving environment quality has taken concrete shape.

The organization recognizes its social responsibilities and is continuously engaged in contributing to the communities in the region. Ethical practices are pursued through education and training of customers. Public health and safety are given paramount importance. The company ensures that the community in and around the complex is aware of the plant's activities and is educated in safety procedures. A well laid out off-site and on-site emergency response plan which involves participation of local authorities and public around the complex has been formulated and implemented. Responding to local needs the company has extended support to people in the fields of health, education, and environment.

Case study

During the last two years over 150 million rupees have been spent on implementing an environment improvement programme. Five initiatives were undertaken as part of the programme. The key drivers for adopting the programme were the availability of latest technologies and processes (like

hydrolyser stripping technology from M/s Stamicarbon, Holland, and ISO 14000 environment management systems), expected scarcity of water in coming years, and a concern for the growing population around the complex.

The approach adopted was to identify areas that needed improvement, measure and quantify the critical parameters, and carry out the root cause analysis of the problematic area.

The main challenges faced during the implementation of the schemes were a paucity of resources, retrofitting new technology in old plants, and the high cost and long payback period for investments in pollution control equipment. These were overcome through adoption of novel strategies to make the environment improvement schemes more cost-effective. Problem areas were approached afresh and operating personnel were involved in seeking innovative solutions. A philosophy of maximizing the in-house design and fabrication of the pollution control equipment was adopted.

Water harvesting

A water harvesting reservoir of 450 000 m^3 capacity was constructed during 2001 within the SFC Kota complex at a cost of 12.9 million rupees. The water effluent rate has been reduced from 3500 m^3/hour in 1985 to 400 m^3/hour at present.

Effluent treatment

The SFC has a single effluent discharge stream and the effluent, which fully meets the stream standards, flows through a concrete pipeline to join Kansua Nullah about 2 kilometres downstream. The other initiatives taken are listed below.

- Lagoons are being used to remove TSS (total suspended solids), contributed mainly by the fly ash from the power plant.
- A hydrolyser stripper unit has been installed in 2000/01, which has reduced ammonia and urea to less than 5 parts per million at the urea plant outlet.
- A treatment plant based on the ion exchange method has been installed to purify mercury-bearing water from cell house of the caustic soda plant. The cost of the plant is 3 million rupees.

Recycling

A comprehensive recycling system is in place, which includes the following.

- A recycle tank is used to store ammonia-bearing effluent for reuse.
- The chlorine generated during emergencies is scrubbed with caustic soda in a neutralizing unit and the product – sodium hypochlorite – is sold.
- The spent catalyst is sold to authorized dealers for reprocessing.
- Fly ash is used as raw material for India's first sludge-based cement plant, for brick production and is also sold to external parties.
- Oil skimmers and recovery systems have been installed in the drains of the plants to remove and reuse oil.

Waste prevention

The SFC has been using better quality salt for the caustic soda plant. This has reduced the generation of brine sludge, a hazardous waste, by 30%.

Air pollution

- Electrostatic precipitators and bag houses have been retrofitted on chimneys of the power plant, cement plant, and carbide kiln to reduce dust emissions to levels lower than prescribed.
- The chimneys have been designed to minimize ground-level concentration of sulphur dioxide.

The company has tried to reduce the payback period for investments in some of the pollution control equipment by reusing recovered pollutants (which reduces costs) and by selling the rest (which increases revenues).

The cost containment measures were directed towards reduction in the cost of the pollution control equipment through thorough technical analysis of the requirements and maximizing the use of the available equipment. The concept of in-house design and fabrication of equipment to reduce the costs and maximizing the usage of existing equipment in environment improvement schemes was used gainfully.

Some of the quantifiable environmental benefits of the project are as follows.

- The effluent generation from the complex has reduced by half in two years. This has also resulted in reduction in overall water consumption of the unit, which has reduced from 1200 m^3/hour to 800 m^3/ hour.
- The dust emissions from the stack are at a level of 80–100 mg/Nm^3 as against the government norm of 150 mg/Nm^3.

Case study at a glance

- Capital investment: 150 million rupees in the last two years.
- Recurring investment: 30 million rupees per year.

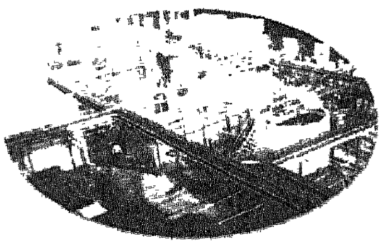
Technical facets covered by the project

- Hydrolyser stripper unit commissioned in February 2001 at a cost of 59 million rupees.
- Installation of cooling towers in caustic soda plant, PVC plant, and carbide plant at a cost of 5.5 million rupees in order to convert once-through cooling systems into circulation cooling systems, thus reducing water consumption and effluent generation.
- Installation of 120 tonnes dry fly ash handling system in a 35-MW power plant at a cost of 2.5 million rupees for using fly ash.
- Construction of water harvesting reservoir of 0.45 million cubic metre capacity for water storage at a cost of 12.9 million rupees.
- Installation of improved 'EPIC' ESP management system for optimized control of rapping to reduce suspended particulate matter from the chimneys of the 35-MW power plant and a 30% reduction in power consumption of ESPs.
- Installation of Fundapack filter to remove mercury from the caustic lye being sold in the market thereby reducing the potential environmental hazards to consumers.
- Installation of oil skimmers in the drains in order to remove the spilled oil from water.
- Using flocculents in the cement plant to reduce the high suspended solids in the effluent stream at a cost of 0.7 million rupees a year.

Waste Water Treatment & Recycling

You see effluents, we see profits!

Effluent Treatment

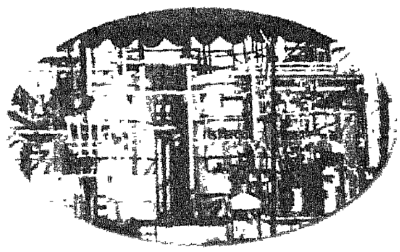


A total water management system for zero discharge to Techumseh Products (India) Ltd. Delhi

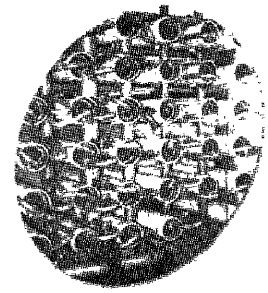


Common effluent treatment plant treats 4000 m³/day textile effluents at Kasipalayam, Tirupur

Recycling

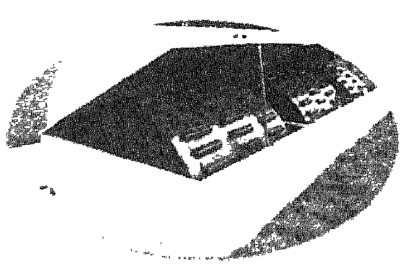


At IFFCO, Phulpur, an effluent recycling plant comprising high rate solids contact clarifier, continuous sand filter, chemical dosing system, cartridge filters and reverse osmosis module designed for 127.5 m³/h recovered water with TDS less than 400 ppm

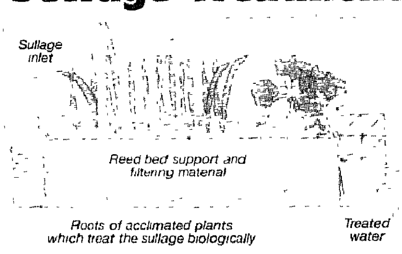


• Hindustan Lever Limited • Tata Cummins • Tata Timken • Dr. Reddy's • Samcor Glass Ltd. • Gujarat Ambuja Cement • Triveni Tissues • Hyundai • Samtel....

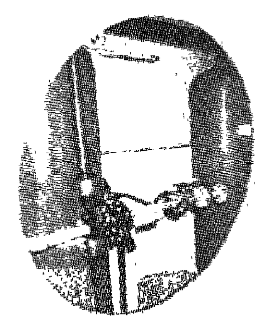
Sewage Treatment



INDION® Packaged sewage treatment plant treats and purifies sewage from institution for reuse in toilet flushing, gardening and car washing



INDION® Reed Bed - An eco-friendly system to treat and recycle sullage/sewage



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Waste Management and Resource Conservation

CASE STUDY

10 BSES Ltd

Background

The BSES Ltd runs a 500-MW coal-based power station at Dahanu, Maharashtra, that produces electricity for consumers in the Mumbai suburbs. It has other divisions like supply, contracts, telecom, and joint ventures with various government and non-governmental organizations. The company undertook a project to reduce generation of spent grease and recycling of lubricating oils.

Environmental profile

The BSES Ltd has in place an environmental policy at both the facility and company levels. The company was awarded the ISO 14001 certification in 1999. It has a committee of directors (environment) at the corporate level, which periodically reviews all environment-related matters. At the international level, the BSES conforms to all treaties to which India is a signatory (Kyoto Protocol for reduction of greenhouse gases and the Montreal Protocol for phasing out of ozone depleting substances).

The company is a member of the national task force constituted by the Central Pollution Control Board for achieving environmental improvements in thermal power stations. The environmental management system at the DTPS (Dahanu Thermal Power Station) clearly states the goals and the time frame within which they have to be achieved. Some of the environmental initiatives undertaken by the company in the recent past are given below.

Clean air initiative

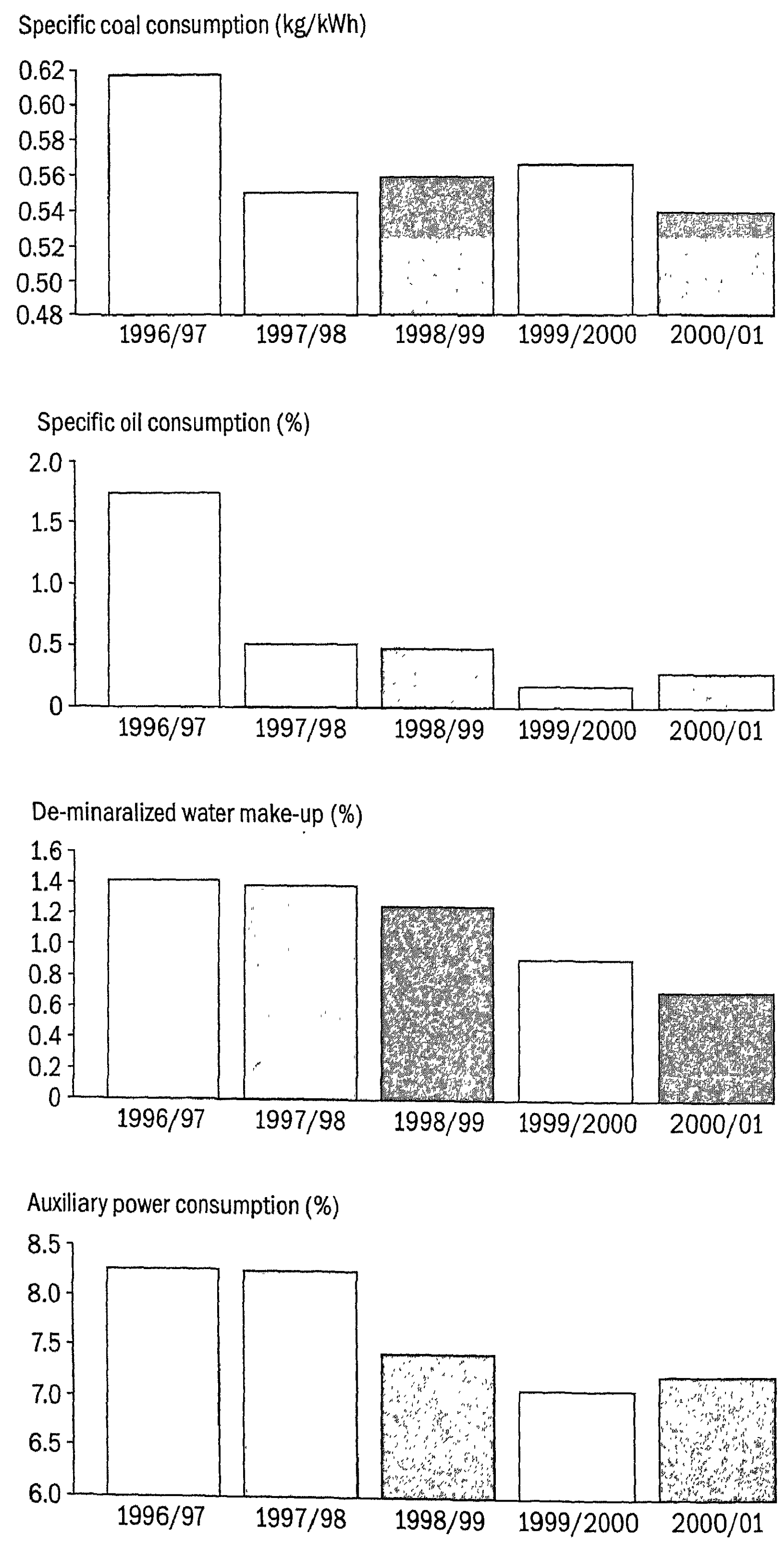
The company maintains TPM (total particulate matter) emissions from stacks below 125 mg/Nm^3 on an hourly average basis. The coal is unloaded in wagon tipplers and coal dust during tippling is suppressed using water spray. While conveying the coal, dust generated is extracted through a dust extracting system and then the ventilated air is emitted into the atmosphere. The fly ash in flue gases is in the concentration of 40–55 mg/Nm^3. This fly ash is collected in electrostatic precipitators having a minimum removal efficiency of 99.5%, thereby restricting the TPM to below 150 mg/Nm^3. The company has a state-of-the-art monitoring system for both stack and ambient air quality monitoring.

Water initiative

The company has built a containment area to hold suspended solids in storm water within the holding pond. The temperature of the sea water used for condensor cooling is maintained through a 3.5 km-long, 220 metre-wide pre-cooling channel, which cools the water through convection and maintains the differential below 5 °C. The company has implemented a programme for 100% fly ash utilization. The fly ash is collected and transported to the ash pond in the form of slurry. As the ash settles in the ash pond, the clear supernatant is let out into the creek through intermediate ponds. At the DTPS, the quality of ash pond effluent with respect to suspended solids and pH is monitored to ensure that they are below 100 mg/litre and between 6.5 and 8.5, respectively.

Resource conservation initiative

The DTPS has one of the best heat rates in the industry. This rate indicates the overall efficiency of the station indicating optimum use and conservation of resources. The resources required for power generation like de-mineralized water and fuel oil are carefully monitored so as to achieve the best level of consumption in the country. In order to prevent erosion by the sea, the company has constructed an anti-erosion bund.



Specific resource consumption at Dahanu thermal power station: 1996/97–2000/01

Solid waste initiative

The company has set up a joint venture coal washery to cater to its need for indigenous coal, thereby reducing the ash content in coal and thus the total ash generated from the power station. It has also undertaken a project to reduce generation of spent grease.

Green initiative

The land on which the DTPS was established was marshy and barren. The company's six-year efforts have created a green cover with over 0.4 million fruit-bearing trees of diverse nature. Additionally, there are some 10 million mango trees for the protection of the coastline adjoining the power station. The company has adopted a village under the joint forest management scheme of the Government of Maharashtra. In order to re-establish the forest cover, the company encourages the villagers to plant trees around the village by supplying saplings.

The company has taken up a number of programmes for social development within Dahanu, especially in the fields of education and health. It has helped construct various schools and colleges, and equipped them with lab and computer facilities. Scholarships have been instituted in technical schools. The company reaches out with free medical assistance through its doctors, medicines, and hospitalization aid. The company has also provided clean drinking water by providing over 60 borewells in the area.

The compliance performance of the power plant is evident from Table 1.

Table 1 Compliance with environmental standards

Parameters	***MPCB* limits***	***Company's performance (2000/01)***
Stack		
TPM (total particulate matter)	150 mg/Nm^3	90.01
SO_2 (sulphur dioxide)	81.30 TPD	46.98
NO_x (TPM at 15% excess oxygen v/v)	150 PPM	85.96
Condensor cooling water		
Hydrogen ion concentration (pH)	6.5-8.5	7.95
Free chlorine	0.50 mg/litre	Nil
Differential temperature	<5 °C	3.60 °C
Ambient air outside plant premises		
SPM (suspended particulate matter)	100 μ g/m^3	35.72
SO_2	30 μ g/m^3	5.76
NO_x (oxides of nitrogen)	30 μ g/m^3	6.69
Boiler blowdown		
Suspended solids	100 mg/litre	6.68
Oil and grease	20 mg/litre	Nil
Copper	1 mg/litre	Nil
Iron	1 mg/litre	0.04
Domestic sewage treatment (colony)		
BOD (biochemical oxygen demand)	100 mg/litre	50.59
SS (suspended solids)	100 mg/litre	49.87
Domestic sewage treatment (thermal power station)		
BOD	100 mg/litre	44.54
SS	100 mg/litre	41.78
Ash pond effluents		
pH	6.5-8.5	8.02
SS	100 mg/litre	21.90
Oil and grease	20 mg/litre	Nil

* Maharashtra Pollution Control Board

Case study

In order to reduce waste lubricant, the company undertook a project to replace the currently used Servotak-40 lubricating grease with Molub-Alloy 8031/3000. Since inception, the six coal mills used the Servotak-40 lubricating grease and the disposal of the 24 barrels of waste lubricant generated every month was proving to be a problem.

In order to deal with this problem, the company approached M/s Stein, which proposed a closed loop forced lubrication system that would use 30 g/min/mill of spent grease. However, the modifications required for the same were costly and the reliability of the system not very sure.

In consultation with BHEL (Bharat Heavy Electricals Ltd) and Castrol (India) Ltd, the company then replaced this lubricant with another high performance lubricant, Molub-Alloy 8031/3000 from Castrol (India) Ltd. With this, the requirement of lubricant was reduced to 2.77 g/min/mill per month generating 3 barrels of waste against the earlier 24 barrels.

The programme was undertaken in consultation with BHEL and Castrol. All the technical inputs were given from their end and were evaluated by the engineers at the company. The trials were undertaken under the supervision of BHEL and Castrol. No modifications were needed in the system other than replacing Servotak-40 with Molub-Alloy 8031/3000 and adjusting some time for greasing. All the operating parameters like vibration, wear debris analysis, temperature of girth gear and pinion were observed and found satisfactory.

The replacement of Servotak-40 with Molub-Alloy 8031/3000 proved not only economical but also very eco-friendly. It reduced generation of waste by 90%. The spent grease could also be recycled after processing, which further reduced the waste generation.

This replacement of one lubricant with another led to a direct cost saving of 0.85 million rupees per annum along with other environmental benefits mentioned above.

Some of the quantifiable environmental benefits of the project are given in Table 2.

Table 2 Cost-benefit analysis

Product used	Servotak-40	Molub-Alloy 8031/3000
Unit cost	Rs 51/kg	Rs 435/kg
Lubricant consumption		
per day/mill	40 kg	3.8 kg
per year/mill	146 000 kg	1387 kg
Lubricant cost/year/mill	Rs 744 600	Rs 603 345
Lubricant cost/year for six mills	Rs 4 467 600	Rs 36 20 070
Savings	–	Rs 845 530 + Saving in inventory cost, disposal cost, and handling cost.

The key motivator to programme adoption was the management's keen desire to reduce waste, dispose waste efficiently, and conserve resources so as to be environmentally responsible.

The revenue generating potential of the model is evident from the fact that the results of the programme are fully replicable and transferable.

Case study at a glance

The BSES Ltd runs the 500-MW coal-based DTPS (Dahanu Thermal Power Station) in Maharashtra. The company undertook a project to reduce generation of spent grease and recycling of lubricating oils. The DTPS approached M/s Stein, who proposed a closed loop forced lubrication system, which would generate 30 g/min/mill of spent grease. However, the modifications required for that were costly and the reliability of the system not high.

The company then approached BHEL and Castrol, who gave all the technical inputs. The trials were undertaken under the supervision of BHEL and Castrol. No modifications were needed in the system other than replacing Servotak-40 with Molub-Alloy 8031/3000 and adjusting some time for greasing. The company thus successfully replaced one lubricant with another high performance lubricant, reducing the requirement of lubricant to 2.77 g/min/mill per month and generating 3 barrels of waste against the earlier 24 barrels.

CASE STUDY

11 Godrej & Boyce Mfg. Co. Ltd

Background

The G&B (Godrej & Boyce) is a company controlled by the Godrej group. Pirojsha Godrej Foundation, a public charitable trust holds about one-fourth of the company's share capital. The company has 26 branches and 45 showrooms and a network of wholesale dealers. The G&B and Godrej Appliances Ltd together have a strength of 10 000 employees. The combined turnover for 2000/01 touched nearly 12.5 billion rupees.

The company manufactures and markets a wide range of consumer durables, industrial products, electronics equipment, and software. All these products are certified to either ISO 9001 or ISO 14001 or both.

Environmental profile

The Godrej corporate environmental policy, signed by its managing director, was released in 1998, which clearly states that the company is committed to profitable growth in business through sustainable development and continual improvement in environmental performance. The policy has focus on the following actions.

- Adopt and institutionalize environmentally responsible practices
- Conserve water, energy, and resources
- Improve pollution-prevention practices
- Reduce generation of waste through recycling and reuse
- Dispose of wastes in an environmentally responsible manner
- Conserve and enhance green cover and biodiversity
- Enhance environmental awareness amongst the employees, sub-contractors, vendors, customers, and neighbouring community.

The policy assures compliance with local and national environmental legislation and regulation. The policy is also communicated to all employees and business associates, and made available to the public.

Over the years, several environmental management programmes have been implemented by the company for improving the environmental performance.

- Construction and operation of a secured landfill for the disposal of hazardous waste from the industrial processes
- Incineration of paint waste
- Construction and operation of 5 tonnes/day composting plant for garden waste
- Construction and operation of 1.5 tonne/day vermicomposting plant
- Installation of a recycling plant for 100 m^3/day of treated industrial waste water
- Installation of foaming equipment based on hydrocarbon route, which is having a zero ozone-depleting potential (this has completely phased out the usage of Freon 11 from foaming operation).
- Manufacturing energy-saving refrigerators (the Pentacool series of refrigerators are environment-friendly and energy-efficient). Compared to the standard energy consumption of 1.82 kWh/day for a 235 FF refrigerator, the new Pentacool model consumes only 1.5 kWh/day. Certain models are

also made completely free of CFC (chlorofluorocarbon), HCFC (hydrochlorofluorocarbon), and HFC (hydrofluorocarbon). The average water consumption per refrigerator has been brought down from 248 litres to 130 litres).

- Energy-saving in manufacturing (the average energy consumption for manufacturing a refrigerator has been brought down from 32.4 kWh to 25.13 kWh).
- Reduction in usage of wood in construction by the use of alternative material like aluminium and glass.
- Use of concrete blocks in the construction of walls instead of clay bricks at several places.

Case study

When the company undertook the development of its Industrial Garden Township in 1948, the management ensured that the industry and biodiversity co-exist. Environment is one of the five values identified by the G&B for itself, and it tries to strike a balance between industrial progress and preservation of the environment. Switching to cleaner processes and fuels, recycling of materials, water and resource management, and waste minimization are part of its strategy to minimize the damage to the environment.

High priority is accorded to the preservation of the existing cover of vegetation and also to increase it with the help of in-house nursery and green houses. The company is actively interacting with Soonabai Pirojsha Godrej Foundation, which is in possession of a large tract of land to the east of the Eastern Express Highway at Vikhroli in Mumbai.

Pirojshanagar epitomizes a blending of man, machine, and nature. The uniqueness of this area is its well-maintained natural environment, which has not only been protected but also greatly enhanced. A large expanse of mangrove forest, perhaps the best on the west coast, adjoins this township. The forest is so well protected that a number of migratory birds, including flamingoes, winter here.

Considering the tremendous potential of the mangrove ecosystem, the company along with the Foundation has decided to preserve it for posterity.

Since G&B's main products are consumer durables, industrial products, and electronics equipment, the manufacturing process discharges liquid effluents, and hazardous waste. All these, if mis-handled, are harmful to the environment. The company has, therefore, used government guidelines and the experiences of expert agencies to minimize the effect of the waste.

Waste water treatment and discharge

Liquid effluent from various manufacturing divisions are collected and treated in the CETP (common effluent treatment plant). The plant has a capacity to treat 1200 m^3/day of liquid effluents. Presently, it is treating 600-700 m^3/day of effluent to the standards prescribed by the pollution control board. A part of the effluent is recycled and recovered for the operation of CETP, and for gardening.

Energy, fuel, and solvent usage

The G&B has reduced the consumption of electrical energy, fuel oils, and other hydrocarbons in its plants (Table 1).

It is evident from Table 1 that the consumption of fuels like FO (furnace oil), HSD (high speed diesel), the LDO (light diesel oil), is on the decline, and part of the liquid fuel has been substituted with eco-friendly gaseous fuel. Continuous efforts are being made to switch to pre-treatment systems in which solvents are not used.

Table 1 Reduction in consumption of energy, fuel, and solvent

Item	Year 1998/99	1999/2000	2000/01
Electrical energy (MWh)	39541	39306	36599
FO/HSD/LDO (kilolitre)	6038	5622	4067
LPG (tonnes)	330	225	125
Lubricating oil (kilolitre)	127	385	298
Grease (tonnes)	3	2.3	2
Solvents (kilolitre)	267	240	216

FO - furnace oil; HSD - high speed diesel; LDO - light diesel oil; LPG - liquefied petroleum gas

Air emissions

The ambient air quality as per the monitoring carried out in the industrial premises at three representative locations is well within the limits set by the CPCB (Central Pollution Control Board). This is the result of several measures taken by the company to protect the environment.

The various manufacturing divisions have 164 stacks/vents. Out of these, 49 are for combustion sources. At present, combustion sources are HSD, LDO, furnace oil, and PNG (piped natural gas). Attempts are being made to switch over totally to PNG in a phased manner. Particulate emissions are also within permissible limits. The reaction gases are mainly air from ovens, spray booths, pickling/pre-treatment tanks, scrubber outlets, and recovery cyclones. The company has provided wet scrubbers to electroplating/pretreatment tanks; cyclones to cutting, grinding, and powder coating application; and water curtains to spray booths.

Significant resource conservation

The G&B has taken several measures and put in place processes to conserve resources through recycling and reuse (Table 2).

- Liquid painting has been replaced with environment-friendly powder painting in the office furniture division. A cyclone recovery system has been installed for the recovery of waste epoxy powder from powder coating operation.
- Replacing wood with recyclable plastic in the office furniture division has reduced wood consumption by 80 tonnes/year.
- The practice of reuse has saved 40 tonnes/year of corrugated packaging material.
- Office furniture division has reduced the usage of electricity by 18%, water by 21%, and fuel by 17%.

A fume extraction system has been installed for pre-treatment fumes in metal pre-treatment section.

Table 2 Recycling and reuse

	1998/99			1999/2000			2000/01		
Item	TC	R	R(%)	TC	R	R(%)	TC	R	R(%)
Water ($m^3 \times 1000$)	711	180	25.3	632	180	28.5	550	202	36.7
Epoxy powder (tonnes)	220	–	–	219	4.66	2.1	146	3.77	2.5
Lubricating oil (kilolitres)	–	–	–	44.4	27.4	61.7	50.2	33.2	66.1
Mazak dross scrap (tonnes)	728	66	9.0	566	91	16.0	410	51	12.4
Brass cuttings (tonnes)	1080	480	44.4	1003	336	33.5	651	435	66.8

TC - total consumption; R - recycled/reused

Conservation of water is another important focus area in the company. Several measures are taken to reduce the consumption of water by reduction, recycle, and reuse.

- Cascade type rinse baths instead of once-through rinse
- Use of automated plating/pre-treatment lines instead of manual system
- Creation of awareness among the employees regarding the importance of water conservation.

The average industrial consumption of water for the last three years has substantially reduced (Box 1).

Box 1

Financial year	*Consumption of water*
1999/2000	1507 m^3/day
2000/01	1160 m^3/day
2001/02	1156 m^3/day

Secured landfill

The G&B has constructed an SLF (secured landfill facility) for the management of hazardous waste generated in the Godrej complex (Table 3). As per the requirements of the Maharashtra Pollution Control Board under Hazardous Waste (management & handling) Rules, 2000, these wastes have to be managed scientifically and have to be disposed of at an SLF.

The different components of the hazardous waste management system are as follows.

- Handling
- Storage
- Transportation
- Treatment and disposal.

Table 3 Hazardous waste generated and its disposal (tonnes)

		Year		
Hazardous waste	***Mode of disposal***	***1998/99***	***1999/00***	***2000/01***
ETP sludge	Secured landfill	433.00	396.00	347.0
Paint waste	Incineration ash to secured landfill	65.00	28.00	21.0
Buffing waste	Secured landfill	2.55	8.55	12.0
Pretreatment sludge	Secured landfill	43.30	37.80	23.8

The construction department of the G&B was facilitated with the technology by the NPC (National Productivity Council), which has substantial experience in designing SLFs in India. The envirotech group of the construction department carried out an EIA (environmental impact assessment) study of the SLF. Based on the EIA study recommendations, the land was earmarked and the SLF was designed. In the process, 5000 tonnes of hazardous waste will be disposed of in the first phase of the programme (Box 2).

The first phase of the SLF was commissioned in June 2000. Hazardous solid waste is generated from the various manufacturing plants of the G&B and Godrej Appliances Ltd. A common effluent treatment plant is located in the Godrej complex, which handles incineration of paint sludge and waste epoxy powder. Some salient features of the SLF are discussed below.

Box 2

Secured landfill facility

- SLF area : 90 × 60 m – each phase
- No. of phases : 4
- Total area : 180 × 120 m – all 4 phases
- Duration of phase 1 : 10 years
- Quantity of hazardous waste to be disposed of in phase 1 : 5000 tonnes

- Construction of the SLF based on the design of the NPC
- Groundwater and soil protection through the provisions of an impermeable liner system at the base of the facility
- Surface water protection through diversion of surface run-on and proper capping after the operational life of the facility
- Prevention of the deterioration of ambient air quality through scientific operation plan of the SLF
- Provision of leachate removal, collection, and treatment
- Closure of the facility and post-closure monitoring.

Case study at a glance

The Godrej group has inherited environmental awareness from its early days. Hence, the family-owned group has periodically initiated new processes for better waste and energy management. Constructing a secured landfill, shifting to powder coating in its furniture division, reclaiming waste water, and educating its employees about better resource utilization are some of the main initiatives by the company to reduce the load on the environment.

- The common effluent treatment plant treats 600–700 m^3/day of liquid effluent generated from various manufacturing divisions.
- The consumption of electrical energy, fuel, and solvents in the plant has remarkably reduced. Part of the liquid fuel has been substituted with eco-friendly gaseous fuel.
- Liquid painting has been replaced with environment-friendly powder painting.
- A cyclone recovery system has been installed for the recovery of waste epoxy powder.
- The practice of recycle and reuse saves 40 tonnes/year of corrugated packaging materials.
- The average industrial consumption of water has reduced from 1507 m^3/day in 1999/2000 to 1156 m^3/day in 2001/02.
- The secured landfill facility constructed by the G&B is expected to dispose of 5000 tonnes of hazardous waste.

CASE STUDY

12 The India Cements Ltd

Background

The ICL (India Cements Ltd), set up in 1946, owns seven cement plants – three in Tamil Nadu and four in Andhra Pradesh – with a total capacity of 9 MTPA (million tonnes per annum). Its turnover, in 2000/01, was over 14 billion rupees. It employs over 4500 people. Its products are as follows.

- 33, 43, and 53 grades of ordinary Portland cement
- Sulphate-resisting Portland cement
- Portland Pozzolana cement

The ICL's major thrust is to market fly ash (a waste product of thermal power plants) based blended cement.

The ALM (Adanakurichi Limestone Mine) is located at Dalavoi village in Ariyalur district, about 250 km south of Chennai in Tamil Nadu. The capacity of the plant, when initially commissioned in 1997, was 0.8 million tonnes of cement per annum. Now it is upgraded to produce 1 million tonne per annum.

Environmental profile

The ICL's environment policy commits itself to complying with all relevant environmental regulations to continually improve its environmental performance by conserving energy, minimizing waste, and where possible, utilizing waste, and to propagate its environmental policy to all employees and other interested parties. The ICL is in the process of installing an environmental management system at its three plants in Tamil Nadu with a view to applying for ISO 14001 certification. Accredited lead auditors oversee operations here. Qualified environmental engineers man the environmental department at all seven plants.



Green belt development along haul road

The ICL is currently involved in the 'Green Aid Plan', jointly conducted by the Energy Management Centre, Ministry of Power, Government of India, and the Japan External Trade Organisation, Government of Japan. The Plan deals with energy conservation and waste utilization.

The ICL regularly competes for awards based on productivity, quality, and environmental performance.

Case study

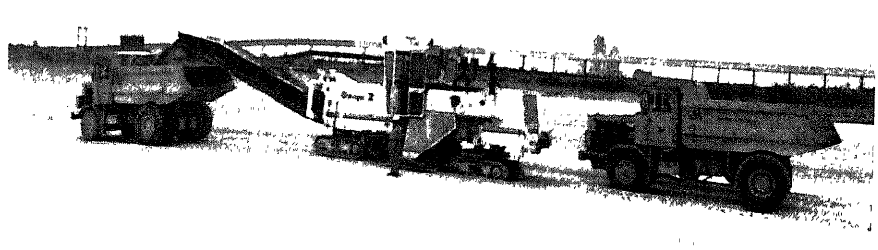
Conventionally, limestone – the major mineral required for cement manufacturing – is mined using opencast mining technology, which involves high safety norms. The mines are mostly situated in remote areas. This calls for innovation of technology to mine limestone safely and exploit the maximum potential of the deposit as a conservative measure. The invention of surface miner has been a breakthrough in addressing the environmental issues related to opencast mining.

The ICL has installed the ecofriendly surface miner at the ALM. A surface miner – 'the total mining machine' – can excavate, size, and load material at one go without prior face preparation. Some of its functions are listed below.

- Eliminates the need for drilling, blasting, surface levelling, dozing, and primary crushing.
- Allows selective cutting and segregation of limestone, and thus makes it easier to recover mineral and to improve its quality.
- Enables work near residential areas; this leads to higher resource recovery.
- Enables sequential cutting, sizing, and loading; this emits no dust.
- Improves fill factor that lets only crushed material be transported increasing load per truck, thus reducing fuel consumption.
- Lets crushed material be directly loaded onto dumpers; this reduces noise.

The limestone deposit is an intricate one with alternate layers of limestone and marl. Consequently, the physical setting of the deposit makes the choice of surface miner effective to overcome the quality problem. The ICL has deployed surface miners to remove the limestone in slices and marl separately so as to control the grade of the limestone produced.

The main constraint of the deposit is the presence of marl in varying forms. The lithology of the area indicates that marl is deposited in alternate bands. By adjusting the cutting depth, it is possible to selectively mine the limestone bands and marl separately, thus improving the quality and recovery of the limestone mined. Selective mining of the limestone bands without contamination enables the usage of low-grade limestone. By utilizing low-grade



Surface Miner

limestone, the ICL is conserving natural resources, and simultaneously eliminating/reducing the additional cost incurred during mining.

As part of its environment management programme at the Dalavoi plant, the ICL has built bunds to preserve a seasonal nallah along the western side of the mine. It regularly monitors the groundwater level. It has built a rainwater harvesting tank on the plant premises, into which excess water from the mines is pumped. The rainwater and groundwater are being used by colony residents as well as to develop a green belt over one-fourth of the premises to maintain ecological balance and to reduce the greenhouse effect. This also acts as a barrier for dust and noise.

The main air pollutant of any cement plant is SPM (suspended particulate matter). The matter is collected by electrostatic precipitators at the kiln, clinker cooler, coal mill, and the cement mill, and by bag filters at all transfer points. The matter is recycled in the process. Water spraying controls the fugitive emission. The process generates no effluent. The domestic effluent, after being treated at the aerobic sewage treatment plant, is used for gardening and green belt development. Hazardous wastes such as the LSHS (low sulphur heavy stock) sludge and used lubricants are collected and sold to licensed users. These wastes are also used in firing the kiln.



ater harvesting tank

Case study at a glance

The ICL (India Cements Ltd) has adopted several ecofriendly methods to reduce energy consumption while improving the quality of the limestone mined, at its Dalavoi plant. Other initiatives taken by the ICL with regard to environmental preservation are rainwater harvesting, green belt development, and waste management in the plant.

- Installed surface miners for ecofriendly mining
- Enhanced productivity by retrofitting
- Reduced power consumption
- Reduced energy consumption for clinker production by retrofitting cooler fans and converting the existing cooler to static pregrate cooler
- Increased proportion of fly ash in the blended cement
- Used low sulphur heavy stock and carbon sludge in cement rotary kiln firing
- Developed a green belt on 25% of the land
- Used sub-grade limestone and paper sludge in the process
- Used alternative materials like phospho gypsum, mill scale, red mud, copper slag, and smoke dust.

CASE STUDY

13 Indian Aluminium Company Ltd

Background

Incorporated in 1938, INDAL (Indian Aluminium Company Ltd) was the first to set up aluminium manufacturing facilities in India. Today, the company has multi-stage operations of the business—bauxite mining, alumina refining, power generation, smelting to semi-fabricated products of sheet, foil, and extrusions as well as aluminium scrap recycling. INDAL plants, mines, and offices are spread across ten states in India. INDAL also holds equity in related companies in extrusions and foil.

The smelter unit of INDAL at Hirakud in Orissa produces primary aluminium by electrolysis of alumina in molten cryolite bath. The refined alumina used in the plant is mainly sourced from the company's alumina refinery plants in Muri in Bihar and Belgaum in Karnataka. The technology used at the smelter unit is energy-intensive and about 46% of the metal production cost is spent on electrical energy. Started in January 1959 with a 10-TTPA (thousand tonnes per annum) capacity, it now has a capacity of 30 TTPA. In addition, an expansion project of the capacity of 27 TTPA is under way.

The plant has four production centres—pot rooms, carbon plant, casting plant, and caster plant. Mainly four categories of products such as Al (aluminium) rolling ingots, Al 1-20K ingots, Al cast coil, and carbon electrode paste are produced in this facility. While the first three categories of products are sent to the semi-fabrication plants at Belur in West Bengal and Taloja in Maharashtra, carbon electrode paste is sold to the ferro alloy industries.

Environmental profile

INDAL believes that, in today's competitive industrial world, every business should adhere to the CSR (corporate social responsibility) principles for its survival and sustainable growth. The company has been managing its CSR issues in a proactive manner involving participation of relevant and interested parties.

In 1986, INDAL formed a corporate cell on environment, health, and safety. Its first policy emphasized on enhancement of awareness and sense of responsibility towards environmental concerns among its employees. In 1994, INDAL revised its policy and shifted focus from management to control and prevention. The approach yielded positive results, and INDAL was the first Indian company to achieve this status of BS 7750 and ISO 14001. Today, 8 out of 11 units of INDAL are certified to ISO 14001. In 2000, INDAL further revised its policy and aligned it with the principles of sustainable development. This helped two of INDAL's units, Hirakud Smelter and Hirakud Power, achieve certification to OHSAS 18001.

Hirakud Smelter did not have pollution control facilities prior to 1980. After the contamination of fluoride in the surrounding water bodies was discovered, it took measures to supply drinking water to all affected communities, undertook cleaning up of landfill sites, installed pollution control facilities, and adopted programmes to improve efficiency in operation.

Water pollution

INDAL has put in place systems to abate water pollution in the plant.

- A rotating biological contractor has been put up to treat the sewage generating from the plant and the canteen. The treated water has BOD (biochemical oxygen demand) of 15–20 PPM (parts per million) against the stipulated limit of 30 PPM and is utilized as a make-up to the scrubber reducing water consumption by 150 m^3/day.
- Cooling towers in the casting plant, rectifier station, and compressors isolate the cooling system from captive pond and maintain zero discharge. Blow-down water from the power plant is re-routed for use in cooling towers in the smelter and scrubbers. This measure has reduced the volume of raw water requirements of the plant.
- Vermifilter (vermiculture ecosystem) consisting of biosoil with bacteria, earthworms, and plant root zone is put up in the plant to treat the effluent from the colony. In the process, bacteria convert the organic matter to plant growth factors while the inorganic matter from waste water is immobilized in the bio medium.
- Close looping cooling towers have been installed for the casting plant, caster plant, rectifier station, compressors, and other equipment to reduce contamination of water.
- Water meters are placed at various location for close monitoring of water consumption, which has led to a reduction in water consumption from 252.32 m^3/tonne of Al in 1996/97 to 21.80 m^3/tonne of Al in 2000/01.

Hazardous waste

Initiatives taken by INDAL to manage the hazardous waste generated in the plant have been very effective (Table 1).

- Cathode residue generated after failure of electrolytic cells are broken into lumps and stored in fully covered sheds with concrete floor as prescribed by the SPCB (State Pollution Control Board). Approval from the SPCB has also been obtained for vertical stacking modular storage to minimize land-use for capping. Also, much efforts have gone into improving the lining life of the electrolytic cells.
- Sludge from the scrubber is collected in a trolley and taken to the disposal site. This is disposed of in a landfill site designed by the National Environmental Engineering Research Institute. The company will later on change to dry scrubbing system, thereby cutting out on sludge generation.

Table 1 Hazardous/other wastes and their management

Description of waste	*Measures taken for management*
Hazardous	
Spent pot lining	Stored in covered shed with concrete floor
Scrubber sludge	Disposed of in a secured landfill designed by the National Environmental Engineering Research Institute
Used batteries	Stored in specially designated place and sold to authorized parties
Used oil	Sold to authorized parties and used in our captive power plant as fuel along with coal
Others	
Aluminium dross from furnace skimming	Sold to authorized parties. Also measures like use of imported (LSM make) alloying materials and cooling the dross with argon instead of water have been taken to reduce the quantity of dross generation
MS Scrap	Sold to third party and some are reused
Papers and glasses	Sold to third party and reduced use of office stationery through implementation of local area network

- Used batteries are collected and stored in a specially designed place and then sold to authorized parties or to the supplier exchange.
- Used oil is reused as lubricants on paste buckets at the carbon plant and as fuel along with coal in the captive power plant. Used oil from the transformer is sold to authorized parties.

Investments made INDAL has made a capital investment of about 46 million rupees so far towards implementing its management programmes for the protection of the environment (Table 2). Needless to say, the payback has been extremely encouraging.

Table 2 Investments made for various environmental initiatives

Area	*Capital invested (million rupees)*
Water pollution management	18
Air pollution management	22
Hazardous waste management	6
Total	46

Case study at a glance

In an area like aluminium manufacturing, which had high-energy consumption and high solid waste discharge, INDAL made a huge investment in finding out a substitute technology that put lesser load on the environment.

- The elimination of mercury in the production process has reduced operational difficulties, maintenance problems as well as detrimental environmental impacts
- The thyristor-based rectifier unit has resulted in conservation of electrical power and also decline in the consumption of fluoride-based chemicals, which are a major pollutant
- Wet scrubbers installed in the plant have reduced the total fluoride emissions from a level of 15-20 kg/tonne of Al to 3-4 kg/tonne of Al
- The presence of roof monitors and dust collectors have substantially contributed towards the reduction in air pollution
- A rotating biological contractor has been put up to treat the sewage generating in the plant. The treated water has BOD of 15-20 PPM against the stipulated limit of 30 PPM
- Management of hazardous waste generating from the plant meets the SPCB approved standards.

CASE STUDY

14 J K Tyre

Background

The J K Industries Ltd has evolved into a corporate entity comprising J K Sugar, J K Agri–Genetics, and J K Tyre. The flagship brand of the corporation – J K Tyre – was set up as a tyre and tube division in technical collaboration with General Tire International, USA (now merged with Continental Tyres, West Germany). J K Tyre exports its products to 64 countries across six continents and is the top exporter of its kind in the country.

The manufacturing facility of J K Tyre started its operation in 1975 at Jaykaygram (Kankroli) near Udaipur, Rajasthan. It rolls out about 58 000 tonnes of tyres, tubes, and flaps annually, deploying about 2000 people. In order to meet market demand and maintain technological leadership in the Indian market, another tyre plant at Banmore, near Gwalior in Madhya Pradesh commenced its commercial production in 1991 while Vikrant Tyres Ltd, Mysore, was acquired and modernized by J K Tyre in 1997. With a turnover of 15 000 million rupees, J K Tyre is the 16th largest tyre manufacturer in the world.

J K Tyre has been the pioneer in radial technology in India. As early as mid-1970s, it became the first Indian company to launch steel-belted passenger tyres and light truck radial tyres. Over the years, this technology has been perfected enabling J K Tyre to showcase an enviable track record in this field.

Environmental profile

J K Tyre has imbibed a philosophy to remain environmentally friendly, and as a result of its endeavour to pursue green technology, all its facilities are certified for international quality systems like ISO 9001/ISO 9002, QS 9000, and ISO 14001; and are striving towards Total Quality Management. Recently, the company was awarded a commendation certificate against its application for EFQM (European Forum for Quality Management). The policy of the environment and safety department at J K Tyre forms the basis of all its plans and actions at each facility with regard to environmental performance.

The green technology at J K Tyre is spearheaded by the Hari Shankar Singhania Elastomer and Tyre Research Institute—a concern of J K Industries Ltd. A significant output of its research is the recent development of 'green' tyres that ensure higher mileage with lower rolling resistance, thus saving fuel.

At J K Tyre, high operational efficiency and definite logistics have been used as a strategy for continually conserving scarce resources. Investments are being regularly made for ecofriendly technologies in areas such as energy-efficient equipment; resource-efficient processes; processes of reuse, recovery, and recycling; optimization of energy utilization in thermal equipment; use of renewable sources of energy; and waste reduction. In addition, the company also regularly conducts programmes towards educating its business associates and public at large towards improving the environment. It has also planted more than 100 000 trees around its plants as a special 'greening' project.

J K Tyre has always strived to use the EMS (environment management system) in its entirety and to derive maximum possible mileage from it rather than limiting it to be a tool for regulatory compliance. Air and water pollution is far below the specified parameters and shows reducing trends indicating the effectiveness of the efforts. Several other initiatives such as bulk procurement; improved packing for chemicals; phasing out of the air-conditioning system based on ODS (ozone-depleting substances) refrigerants; improved monitoring of pollution-control devices; workplace monitoring; and generating awareness in community members have already been taken, even though many of these are not mandatory by regulation. In fact, such initiatives have been cost-effective in addition to having contributed towards prevention of pollution.

Case study

The plant at Kankroli in Rajsamand district near Udaipur is the first tyre plant set up by J K Industries. Its environmental initiative began with the adoption of a structured EMS as a solution to enhance efficiency of the internal management system, reduce waste, prevent pollution, improve environmental performance, and anticipate regulation with proactive environmental policy. It was also understood that, through the devised EMS, significant changes in the company's relationship with local regulatory authorities could be brought about, which in fact has been realized. Measures taken in terms of environmental cleanliness in and around the plant as well as in the operation of the plants are discussed below.

Air emissions

The main air pollutants generated in the plant are the SPM (suspended particulate matter), the ambient RPM (respirable particulate matter), oxides of sulphur, oxides of nitrogen, etc., CO (carbon monoxide), and ammonia.

In order to reduce emissions and provide a clean stack, boilers are installed with various pollution control devices such as multi-cyclones, ESPs (electrostatic precipitators), and dust collectors. Boilers are operated at optimum efficiency to reduce un-burnt coal content in the ash and CO emissions. Sulphur content is monitored in coal/fuel to limit oxides of sulphur. Stack heights on boilers and DG (diesel generator) sets are provided as per regulations. Special water troughs have been fabricated for ammonia carbuoy storage. Components carrying ammonia are inspected regularly to detect corrosion and potential leaks; monitoring devices are provided with alarm to detect leaks, which are attended immediately.

Air emissions through stacks have significantly been brought down to below the prescribed limits (Table 1). All stacks are regularly monitored. As a result of the efforts, the stacks either comply with or exceed the minimum regulatory requirements related to stack heights.

Table 1 Reduction in air pollution through stacks

		Improvement	
Parameter	***SPCB limits***	***From***	***To***
Stack SPM (mg /Nm^3)	150	73	44
Dust collector stacks (mg /Nm^3)	NA	132	<40
Ambient SPM (μg/m^3)	500	176	159
Dip stack (μ g /m^3)	500	NA	0

SPM - suspended particulate matter; NA - Not available; SPCB - State Pollution Control Board

Improved mixing process and installation of alert devices on dust collectors have significantly reduced carbon black in the surrounding atmosphere providing relief to the adjacent township. The emissions from dip unit of dry dip particles have been diverted for collection eliminating fire risk and ambient pollution.

Other initiatives include water spraying during unloading of coal, improved coal storage and containment, disciplining transporters against long idling, use of slurry instead of talcum powder in tube manufacturing, and reducing loose dust through plantation of vegetation.

Effluent discharge

Effluent water is generated from the DM (de-mineralized water) plant, softening plant, cooling tower, boilers, coal-quenching processes, dip unit wash, and the laboratory. An ETP (effluent treatment plant) is in place to treat the effluent water. Transportation of the total effluent is done through hume pipes while treatment tanks are lined to eliminate any seepage. The quality of treated water is checked before usage in an environmental laboratory. Water samples of wells within the plant and in the nearby community are also tested annually to detect any seepage.

Installation of additional aerators and nozzle sprays are under progress at the ETP to further improve the BOD (biochemical oxygen demand) values, which are at threshold levels. A proposal has also been in the pipeline to install an RO (reverse osmosis) plant at a cost of 7 million rupees to reduce generation of effluent water in the plant and the recurring treatment cost. Steps taken have been effective in reducing the quantity of effluent water generated from 650 kilolitre/day to 417 kilolitre/day.

Domestic effluent water is generated from both the facility and the township. The domestic sewage is treated in a state-of-the-art plant installed recently at a cost of 2 million rupees. This has been effective in recovering the process water up to 20% of the total fresh water requirement. The BOD value has been reduced from 70 mg/litre to nearly 10 mg/litre, which is way below the prescribed standards. The treated water is recycled for horticulture.

Over the years, the initiatives have helped J K Tyre reduce its water consumption by 30% and waste water generation by 35%.

Hazardous waste

The plant generates hazardous wastes of category 43 and 44 as per Hazardous Waste (management and handling) Rules, 2000—waste oil, oil emulsions, and oil-soaked materials.

On account of various initiatives taken by J K Tyre, the consumption of oil and generation of used oil have come down significantly in the last few years. Special attention has been given to eliminate oil leaks and to ensure optimum usage life of oils. Oil usage with total loss system has been optimized. Handling, decanting, and refilling systems have been improved to eliminate spillage. The wastes are properly identified, collected in suitable containers, and stored on an impervious ground to prevent seepage in case of leak, and are protected from rains.

The first option is to recycle and reuse waste oil in the process. In case recycling is neither feasible nor economical, it is sold to parties authorized by the State Pollution Control Board for usage by them as raw material. As a last option, the waste oil is sprayed on coal to be burnt in boilers. All oil-soaked waste is also burnt in boilers.

Table 2 Environmental initiatives and benefits

Environmental concern/initiative	From	To	Annual impact (rupees in million)
Resource conservation			
Reduction in excess consumption of dip solution (%)	60		4.53
Recycling of carbon black (MT)	30	100	2.30
Reduction in residual losses in empties	–	–	2.30
Improved recovery of carbon from dust collectors (mg/Nm^3)	132	<50	0.84
Reduction in water consumption (%)	28.0		4.00
Reduction in naphtha consumption (%)	22.6		3.75
Process waste reduction - by weight (%)	17.1		6.16
Reduction in diesel generator specific fuel consumption (%)	5.3		3.70
Recycling of poly (kg)	0	1500	0.10
Optimization of materials (MT)	Assorted		32.50
Gauge optimization on calender (MT)	Assorted		1.50
Fuels and lubricants			
Reduction in high speed diesel consumption (%)	12.5		1.70
Reduction in lubricants cost (Rs in million)	2.48	1.0	1.48
Water			
Domestic waste water recycling (kl/day)	0	200	1.90
Elimination of fresh water usage for ash quenching (kl/day)	40	0	0.38
Elimination of water leaks from hydrant and sprinkler lines (kl/day)	60	0	0.55
Reduction in ozone depleting substances			
Reduction in consumption of chlorofluorocarbon (kg)	158	63	0.04
Reduction in consumption of NH_3 (kg)	60	0	0.06
Plant waste			
Reduction in empties of oil (number of empty drums)	3000	0	0.60

Energy conservation

Energy consumption has been reduced significantly in the plant by improving specific energy consumption parameters like power, compressed air, and steam. The measures included installation of energy-saving devices such as the variable frequency devices, recovery of compressed air, and elimination of occurrence of leaks through a focused leak prevention programme. More than 70 million rupees have been saved in cost of energy since the inception of this structured energy conservation programme in the plant.

Feasibility of using renewable energy sources such as biogas and wind farm is also being explored. Fibre reinforced plastic sheets for utilization of daylight for illumination of the plant and of solar energy for heating water in the cafeteria have already been installed.

Specific consumption of high speed diesel or dip unit burners has been reduced from 0.16 l/kg to 0.14 litre/kg by improving insulation and arresting and sealing leaks from ducting. Specific fuel consumption of DG sets has been reduced from 0.28 litre/kWh to 0.265 litre/kWh by load balancing. The annual consumption of lubricants has also been brought down by 60%.

All activities related to energy conservation, fuel and lubricant optimization, waste reduction, process improvements along with implementation of concepts of recycling, recovery, and reuse have resulted in significant economic benefit through resource conservation.

Case study at a glance

J K Tyre has developed a system that prioritizes environmental issues to be selected for action. It has always strived to use its environment management system in its entirety and to derive maximum possible mileage from it rather than limiting it to be a tool for mere regulatory compliance. It is an example of using such an opportunity to optimize each and every process in the manufacturing of tyres.

J K Tyre has implemented several measures in order to reduce air emissions, effluent discharge, hazardous waste generation, and energy consumption. The important issues addressed in its efforts to enhance environmental performance include the following.

- Adoption of clean processes/technologies/materials
- Energy conservation
- Use of renewable energy sources
- Optimization of fuel and oil
- Recycling, recovery, and reuse of waste
- Improvement of work areas
- Spillage and noise control
- Raw material and natural resource conservation
- Enhancement of green areas within the plant, in the township, and in adjacent localities
- Awareness among the employees and the community.

CASE STUDY

15 Nava Bharat Ferro Alloys Ltd

Background

The NBFA (Nava Bharat Ferro Alloys) Ltd, founded in 1972, has an annual turnover of 3 billion rupees. The plant is located at Paloncha, Andhra Pradesh. The company has four areas of operation—electro-metallurgical, sugar, machine building, and power. The electro-metallurgical division manufactures silico manganese, ferro manganese, ferro chromium, and ferro silicon. Crystal sugar and rectified spirit are produced by the sugar division. The machine building division manufactures process equipment like pressure vessels, heat exchangers, reactors, and distillation plants while the power division operates a 50-MW coal-driven power plant.

Environmental profile

As part of the corporate social responsibility, the NBFA has given emphasis on environmental protection and sustainable development. It has, accordingly, been taking steps to minimize air and water pollution and conserve water, energy, and coal. Some significant environmental programmes the NBFA has effectively implemented are as follows.

- Complete utilization of fly ash
- Conservation of water by recycling and reusing with zero effluent discharge
- Conservation of energy by putting up the required equipment
- Development of green belt

The NBFA has constructed rainwater harvesting pits at its Paloncha site, and participated in the *Neeru-Meeru* programme of the Andhra Pradesh government. To abate water pollution, the following measures have been taken.

- Cooling water is treated chemically and clear water from bed ash pond is re-circulated and partly used for green belt development.
- Regeneration effluents of the DM (de-mineralized) water plant are neutralized and used in the ferro alloy plant.
- Closed cycle cooling systems are installed to eliminate thermal pollution.
- Effluents are regularly monitored and managed to keep them below the prescribed parameters.

The company has installed ecofriendly boilers, high-efficiency ESPs (electrostatic precipitators), and tall chimneys in the plant to mitigate air pollution. Dry fly ash disposal systems and coal-dust extraction/suppression systems have also been put up to reduce the pollution level.

For the year 1992/93, the NBFA was awarded the Best Environmental Improvement Effort by Industries by the Federation of Andhra Pradesh Chambers.

Case study

As power constitutes a major input in its manufacturing process, the NBFA felt the need to set up a power plant. It carried out a detailed study to identify the best ecofriendly technologies available before it went ahead to set up a 50-MW thermal power plant adjacent to its ferro alloy plant at Paloncha. By implementing the recommendations of the study, the NBFA has effectively controlled air and water pollution caused by the operation of the coal-based power plant. Also, the plant has been saving 20 000 kWh of energy by bringing down its auxiliary consumption to 8.4% from the usual 10%. The power plant at Paloncha is the first ecofriendly thermal power plant in Andhra Pradesh and is one of the few such plants in India.

Ecofriendly boilers

The main air pollutants in the power plant are SPM (suspended particulate matter), SO_x (oxides of sulphur), NO_x (oxides of nitrogen), fly ash, and coal dust. As the study suggested, CFBC (circulating fluidized bed combustion) boilers were installed in the plant to reduce SO_x and NO_x levels. The CFBC boilers help reduce the pollution in the following ways.

- Emit less SO_x and NO_x due to lower furnace temperature
- Operate efficiently with low-grade coals having ash content as high as 65%, thereby providing greater fuel flexibility
- Require no oil for low-load operation or flame stabilization as the fluidized bed possesses high thermal capacity
- Simplify operation and maintenance.

Also, the CFBC boilers have been saving the plant a substantial quantity of coal. ESPs are installed in the plant at places, thereby limiting the SPM concentration to below 100 mg/Nm^3 while the statutory limit is 115 mg/Nm^3. Besides, the chimneys at its site are 75 metres tall and have a discharge diameter of 1.8 metres—they disperse emissions over a large area, and bring down ground-level concentration of air pollutants to negligible values.

Fly ash disposal system

The NBFA has implemented a system in the plant for collecting, handling, and the disposal of fly ash. The coal crushing plant is located a kilometre away from the main plant and the residential areas. Dust is sprayed with water to suppress it wherever it is extracted—at transfer points and stockpile areas spread out over the plant. Also, the crusher house and boiler floors are equipped with dust extraction fans.

Fly ash is collected in economizers, pre-heaters, and ESPs and evacuated with the help of vacuum exhausters to silos. A filtering arrangement is provided at the top of the silos, which prevents escape of fly ash into the atmosphere. Fly ash is then loaded onto specially-designed trucks and disposed of to cement and brick manufacturers. Since the fly ash is completely utilized in brick and cement manufacturing, the company does not need to use landfills. Based on initiatives taken by the NBFA, 20 fly ash brick manufacturing units have come up in the area surrounding the plant and there is a good demand for fly ash bricks in the construction of low-cost houses and compound walls. The efforts have made it possible for the plant to achieve 100% disposal of fly ash.

Waste water treatment

The blowdown water from the cooling tower and the regeneration waste from the DM plant are the main source of polluted water in the plant. The cooling water is chemically treated. This reduces blowdown drastically to 20 m^3/hour. The blowdown is used for handling bed ash. The clear water from the bed ash

pond, which is lined with clay to prevent seepage, is re-circulated; part of it is used for developing the green belt. The regeneration effluent from the DM plant is neutralized and used in the granulation system of the ferro alloy plant.

The plant uses a closed cycle cooling system, which eliminates any occurrence of thermal pollution. The system of regular monitoring of effluent parameters has kept effluent limits well below those prescribed by the Andhra Pradesh Pollution Control Board and the Central Pollution Control Board.

Treating the cooling water chemically increased the cycle of concentration to 7 from 2.5. This reduced water consumption by 1500 m^3/day, and brought the consumption level down to 3500 m^3/day. This was further reduced to 3000 m^3/day by recycling water from the bed ash and other small discharges.

Case study at a glance

The NBFA's (Nava Bharat Ferro Alloys Ltd) efforts towards operational efficiency illustrate its environmental consciousness. Before setting up a power plant at Paloncha in Andhra Pradesh, the NBFA had carried out a study to identify the best ecofriendly technology available for a power plant and implemented the findings to effectively reduce pollution as well as to conserve energy.

- Choice of CFBC boilers has reduced SO_2 and NO_x in the gases discharged through the chimneys.
- Installation of high-efficiency ESPs has resulted in reducing SPM in the stack gases.
- Construction of 75-metre tall and 1.8-metre diameter chimneys has resulted in dispersal of particulate matters over a large area leading to negligible ground-level concentration.
- Dry handling and 100% disposal of fly ash to cement and brick manufacturers have ensured a cleaner environment.
- Locating the coal-crushing plant one kilometre away from the power plant has reduced noise pollution.
- Recycling of water used for bed ash handling has resulted in zero discharge from the plant.
- Closed cycle cooling system has precluded the scope for thermal pollution.
- Chemical dosing and increasing the cycle-of-concentration to 7 have reduced cooling tower blowdown and the overall consumption of water by 1500 m^3/day.
- Continuous monitoring of operation of equipment with periodic measurement of pollutants has helped keep the pollution level far below the statutory limits.

CASE STUDY

16 Oil India Ltd

Background

OIL (Oil India Ltd) was incorporated in 1959 as a joint venture of Burmah Oil Company/Assam Oil Company and the Government of India. In 1981, it became a Government of India enterprise. It is headquartered at Delhi, and its major operational areas are in Assam and Arunachal Pradesh. It produces 3.25 million tonnes of crude oil, 50 000 tonnes of LPG (liquefied petroleum gas), and about 1550 million cubic metres of natural gas. Its 1157-kilometre-long trunk crude pipeline carries its oil to the various refineries. It has taken up a few joint venture projects within the country and abroad.

Environmental profile

OIL's safety and environment department controls all operational efforts to minimize environmental pollution. It follows a proactive policy of environmental management, and is well-regarded among statutory pollution control authorities for its strictness in compliance with environmental laws.

OIL produces hydrocarbons through a series of operations such as geophysical exploration, drilling of oil and gas wells, and production and transportation of crude oil and natural gas. In the various stages of these operations, certain inherent environmental hazards are associated with each stage. The pollution control measures adopted by OIL for making the operations environment-friendly are as follows.

Controlling pollution by effluents

The effluent generated during drilling operations is a source of pollution of land and water ecosystems. The steps taken to remedy this situation are the following.

- To contain effluents, effluent pits are designed scientifically.
- To prevent seepage, pit walls are made impervious wherever necessary.
- The pits are compartmentalized for effecting mopping of any floating oil.
- The concept of central effluent pit/emergency pit has been introduced to cope with the situation of heavy rains and prolonged monsoon season, which is an inherent problem for the oil fields of north-eastern India.
- The concept of recycling of drilling effluent has been introduced in OIL and this does not allow any effluent to go outside the well site. The effluent is treated and reused at the site itself at a very low cost. This will lead to zero effluent discharge from the drilling wells in the near future.

Management of formation water

Water is pumped into oil wells for enhanced oil recovery. The water that later comes out is known as formation water. It comes out from great depth and is therefore brackish. This water cannot be released into the open fields because it makes soil saline. It cannot be disposed of in surface streams because it also has other contents: it is mixed with oil (1000–3000 PPM [parts per million]) and dissolved solids (5000–8000 PPM as against 100 PPM in surface streams). Management of formation water is difficult. It was being managed by partial evaporation and disposal in the earlier days of oil production. For better management of the pollution hazard arising out of the produced formation water, OIL has adopted the following processes.

- Formation water is disposed of in disposal wells specially drilled for the purpose and having impermeable layers to prevent any vertical migration.
- Water samples from the nearby potable water wells are regularly monitored to ensure that the discharged formation water has not contaminated the aquifers.
- To overcome the problem of clogging due to the presence of oil in the untreated formation water, OIL has commissioned formation water treatment plants. The water is treated in these plants adopting the process of gas/air flotation and filtration. By this means, oil content in formation water is reduced to 10 PPM and turbidity to almost nil, making it suitable for disposal.
- The earlier practice of using water-soluble demulsifiers has been replaced by the use of oil-soluble demulsifiers. As a result, the oil content is reduced to below 10 PPM. Clarified formation water is now serving the dual purpose of reservoir pressure maintenance and better environmental management.

OIL is also taking steps to reduce the production of formation water at the source itself so that the handling problem can be mitigated.

Arresting air pollution

The factor most responsible for air pollution in an oil industry is the flaring of gas. Apart from the heat and light that it generates, the components of concern in natural gas flares are SO_2 (sulphur dioxide), CO (carbon monoxide), CO_2 (carbon dioxide) and oxides of nitrogen. To combat the effect of heat and light on the environment, flare pits are provided with brick walls with refractory lining. The pits also have a multi-burner facility with a downward tilt instead of a single burner. To reduce the luminosity of the flame, pits have been designed to have an abundant supply of air. This also ensures that CO is not formed, since incomplete combustion of carbon/hydrocarbons leads to formation of CO, while complete combustion leads to formation of CO_2, which is less harmful for human and animal health. The gas produced in this region is free of sulphur, so no SO_2 is formed.

Case study

The main pollutant of an oil or gas well is the effluent. Its overflow, seepage or leakage is difficult to prevent by the conventional practice of digging effluent pits. OIL has innovated a safe method of recycling the effluent that is also cheaper, uses less fresh water, and protects the neighbouring agricultural land.

The system comprises a proper drainage, a brick wall retainer pit behind the desander/desilter tank, two water recycling tanks, one recycling pump, and a 900-m^3 pit. First, a three-chambered retainer pit is dug. In the first chamber, oil is drilled. Sand and silt collect in the third chamber. Water from the well and from the desander and desilter trays comes to these chambers and flows to the second chamber in the middle, then go on to the main drain. Water from the cellar, and also the water for cleaning, flow to this main drain. The drain water is passed through the oil/water separator, where oil is removed, and then through the chemical dozing tank, where alum is added to it to help settle suspended solids. The recycling pump pumps the oil-free water from the underground pit to the settling tanks, where more alum is added. This water is pumped to different points for re-use.

The new recycling system is an improvement upon the old system of effluent pits in many ways.

- An emergency effluent pit of about 900 m^3 is required in the new system, and not one of about 4500 m^3.
- About 1000 m^2 of land is required under the new system, as compared to between 5350 and 6690 m^2 in the old system.
- No extra land is ever required, whereas additional land is occasionally needed in the old system.
- Fresh water needs to be generated for about 2 hours a day instead of 16 hours.
- Much less energy is spent.
- Less effluent is generated.

A cost-benefit analysis reveals that the new system will save approximately 0.44 million rupees per location. Though this amount does not appear to be very significant when compared to the total cost of drilling, but it has a significant positive effect on the environment. This is clear from the extent of land that gets saved as a result of the new system. Land – whether paddy fields or forested – saved from destruction had a good long-term effect on the environment. The recycling system saves about 4000 to 5000 m^2 of land per drilling location. If 10 such drilling locations utilize this sytem, about 40 000–50 000 m^2 of productive land will be saved each year.

Case study at a glance

Oil India Ltd has innovated a safe method of recycling effluents.

- The recycling system saves about 4000-5000 m^2 of land per drilling location.
- The new system uses less fresh water and protects neighbouring agricultural/forested land.
- The new system saves time and fresh water needs to be generated for about 2 hours a day instead of 16 hours.
- The amount of energy spent is far less in the new system.
- Less effluent is generated by the new process.

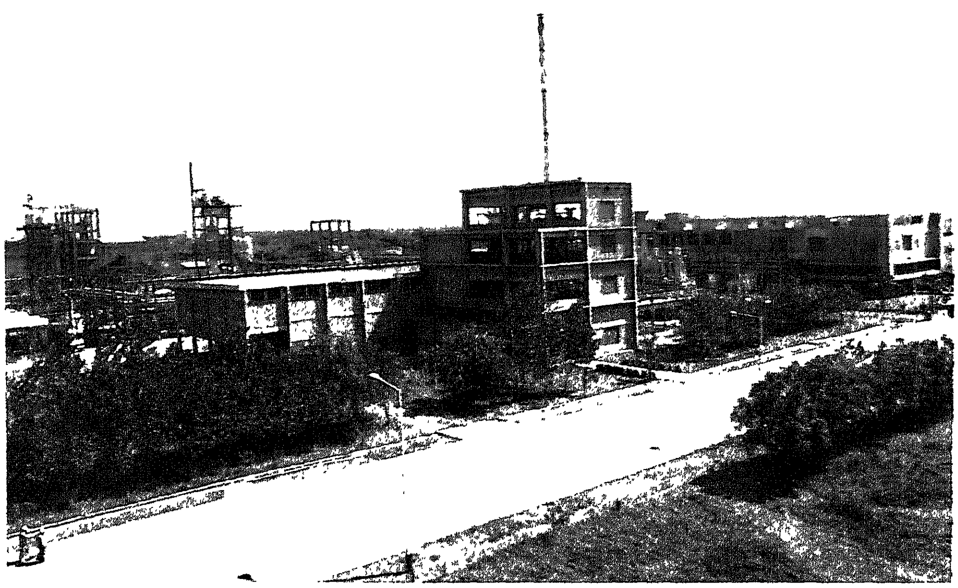
CASE STUDY

17 Shriram Alkali & Chemicals

Background

The SAC (Shriram Alkali & Chemicals), a unit of DCM Shriram Consolidated Ltd and part of the Bharat Ram group, has a 50 000 TPA (tonnes per annum) chloro-alkali plant. The plant manufactures caustic soda lye (50 000 TPA), flakes (33 000 TPA), chlorine (45 000 TPA), hydrochloric acid (115 000 TPA), and hydrogen (1250 TPA).

The plant is located in Jhagadia (Bharuch, Gujarat). It is based on state-of-the-art cell-membrane technology and integrated with energy-efficient captive co-generation power plant with three DG (diesel generation) sets of 6 MW each. It is at this plant that the SAC has undertaken its 0.24 million rupee project to reduce effluent waste by 140 m^3/day.



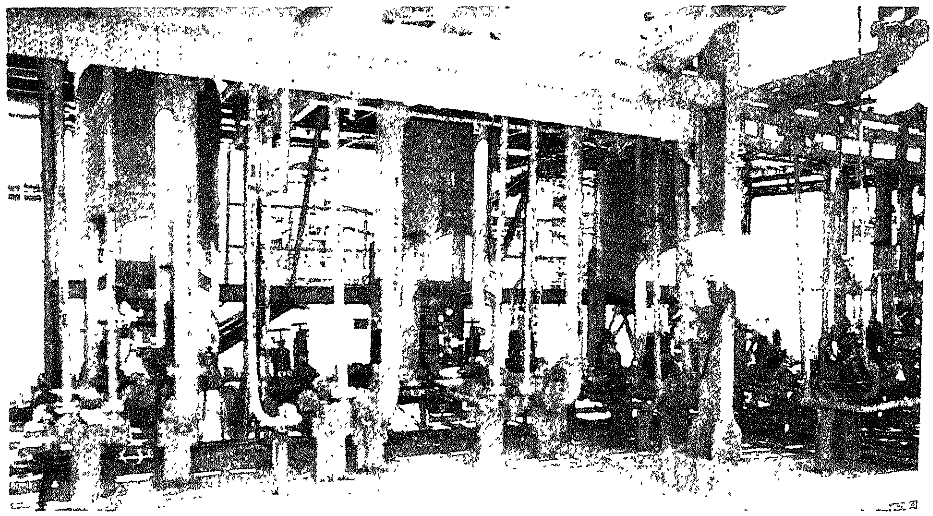
Overview of the unit at Jhagadia, Gujarat

Environmental profile

The company's safety, health, and environment department ensures compliance with its environmental objectives in all its actions. The unit is ISO 9002, ISO 9001, ISO 14000, and OHSAS 18001 certified.

The SAC's management is committed to control pollution and to plant trees on a large scale. Today, there are nearly 15 000 trees in the green belt covering 9 hectares of land at its Jhagadia plant. The company has also recently introduced a rainwater harvesting system at a cost of 2 million rupees, for collection, clarification, filtration, and use of rainwater in the manufacturing process.

To prevent loss of caustic and depleted brine in the cell house during sampling and analysis, the company installed a sampling cone with valve at all sampling points for all electrolysers, and laid a pipeline to empty out samples into the respective storage tanks. A cemented slope was also



Ion exchange columns for ultra pure brine: an innovative process modification to segregate the generated effluents into acidic and alkaline streams, which are used as a substitution of hydrogen chloride for barium chloride preparation and as a substitution of sodium hydroxide in the brine reactor

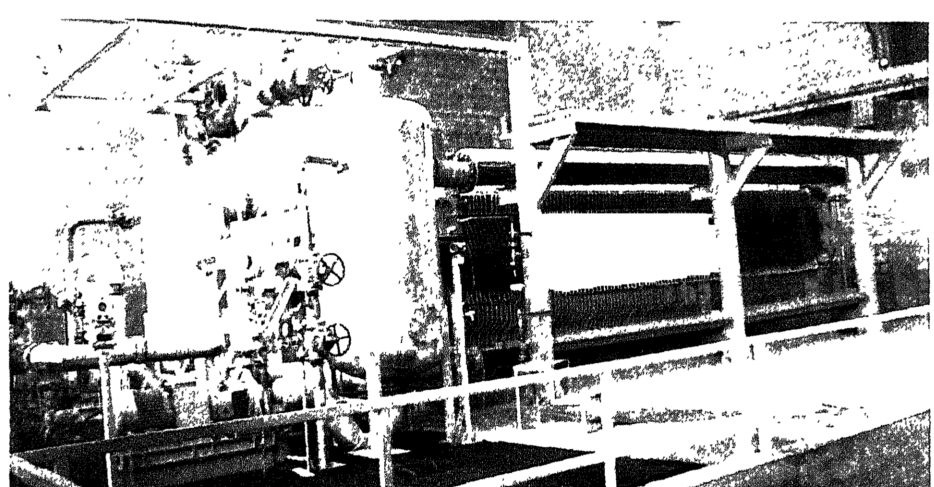
provided below the electrolyser to drain out the electrolyser/membrane washwater and reuse it in the process.

To neutralize the fugitive chlorine, the company provided a chlorine absorption system with caustic as a scrubbing media.

The unit has considerably reduced effluent generation by recycling and reusing effluents—from 3.8 m^3/T in 1996/97 to 0.7 m^3/T of caustic in 2000/01. With a landfill-type solid waste disposal facility, the SAC has also reduced brine sludge generation from 46 kg/MT of caustic in 1998/99 to 44.5 kg/MT in 2000/01.

Case study

The SAC consistently worked towards seeing the Jhagadia plant as the best chloro-alkali plant in the industry. The company has been consistently identifying problems involving effluent generation, carrying out root-cause analyses, and implementing effluent reduction schemes. The initiative has provided a structured method to identify problems, determine the cost of waste due to each problem, and to resolve the problem. It has helped develop cross-functional teams, which suggest and implement corrective action. As a result of all these efforts, the effluent generation has fallen to 400–460 m^3/day in 2000/01 from 578 m^3/day in 1996. Several initiatives have been taken to recycle and reuse the effluent. Some of them are highlighted in Table 1.

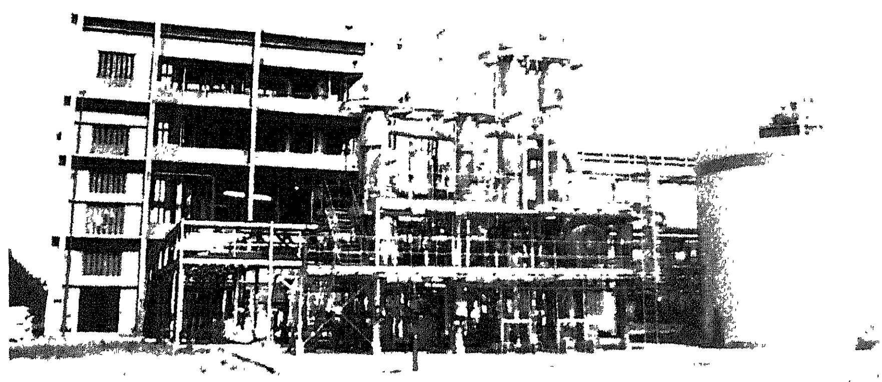


A view of electrolysers: sampling cones with valves at caustic and depleted brine sampling points are installed to empty out samples in respective storage tanks

Table 1

Effluent recycling/reuse schemes

Effluent source	Recycling mechanism	Investment (in thousand rupees)	Effluent reduction (m^3/day)
Gland/ mechanical seal/ accidental spillage or leakage	Collection in a covered pipe/pit to avoid contamination and recycling into brine reactor/return brine tank, hypo tanks as per the chemical nature	50	20
Ion-exchange column regeneration	Segregation of effluents into acidic and alkaline streams for substitution of hydrogen chloride for barium chloride preparation and as a substitution of sodium hydroxide in brine reactor	80	35
Pump seal water and steam condensate	Collection in a covered pipe/pit to avoid contamination and recycling into caustic storage tank	20	10
Cooling tower blow down	Change of temperature at which caustic was fed to caustic concentration unit	10	60
Regeneration effluent	Using toner washing, in the hypo plant, in chemical preparation in place of fresh water	80	15
Total		**240**	**140**



Caustic concentration unit (from 30% to 48%)

To prevent accidental leakage or spillage from glands and mechanical seals, the effluent is collected in a covered pipe or pit and recycled into the brine reactor return brine tanks, or hypo-tower storage tanks as per the chemical nature of the spillage. This has been done at an investment of 50 000 rupees and the system helps reduce the effluent by 20 m^3/day.

Effluent from the ion-exchange column regeneration is segregated into acidic and alkaline streams and are used as a substitute of hydrochloric acid for barium chloride preparation and as a substitute of NaOH in the brine reactor. This has been done at a cost of 80 000 rupees, which reduces effluent by 35 m^3/day.

The pump seal water and steam condensate are collected in a covered pipe/pit and recycled into the caustic storage tank. This was done at a cost of 20 000 rupees and the system reduces effluent by 10 m^3/day.

The temperature, at which caustic is fed to the concentration unit, has been increased to 80°–85 °C, at the earlier level of energy consumption. The heat that was being lost to the cooling tower system, is now being saved— to the extent of 600 kg of steam an hour. This also reduces effluent by 60 m^3/day, and costs 10 000 rupees to implement.

The regeneration effluent, instead of fresh water, is reused for toner washing in the DM (de-mineralized) water plant. This costs 80 000 rupees and reduces effluent by 15 m^3/day.

The environmental payback for the region has been the reduction in effluent. The rainwater harvesting initiative will increase the water table of the area. The company has also developed a green belt.

Case study at a glance

The SAC has successfully leveraged its environment management system as well as technology and in-house R&D for improving environmental standards and resource conservation. In the process, the company has realized many measurable environmental benefits.

- Prevention of leakage or spillage from glands and mechanical seals, by collecting effluent in a covered pipe/pit and recycling it into the brine reactor/return brine tank and the hypo-tower storage tanks as per their chemical nature
- Segregation of effluent into acidic and alkaline streams as a substitute of HCL for preparing barium chloride and as a substitute for NaOH in the brine reactor
- Collection of pump seal water and steam condensate in a covered pipe/pit and recycling them into the caustic storage tank to avoid contamination
- Change of temperature at which caustic was fed to caustic concentration unit to save 600 kg/hour of steam
- Using regeneration effluent, instead of freshwater for toner washing in the DM plant

CASE STUDY

18 Tamil Nadu Newsprint and Papers Ltd

Background

The TNPL (Tamil Nadu Newsprint and Papers Ltd), India's largest paper mill, was promoted by the Tamil Nadu government in view of using bagasse instead of wood pulp as the principal fibre source for manufacturing newsprint and printing and writing papers. The broad objectives of the project were to increase the national production of both newsprint and writing and printing paper, and to utilize a renewable non-conventional raw material, thereby conserving the country's fast depleting forest resources. The TNPL has a long-term agreement for supply of bagasse with six sugar mills in exchange of steam. For this purpose, the TNPL has installed boilers at the respective sugar mills.

Commissioned with an installed capacity of 90 000 TPA (tonnes per annum) of newsprint/fine paper, the TNPL came into being in October 1985, at Kagithapuram in Karur District, about 400 kilometres south-west of Chennai. Major part of its project cost was met by a loan of 100 million dollars from the World Bank. Within a short period, the company had achieved over 100 per cent capacity utilization. Encouraged by its success, the TNPL embarked upon an expansion programme in 1993, to double the production capacity to 180 000 TPA. For the expansion project too, the World Bank extended a direct loan assistance of 75 million dollars. The TNPL employs 1682 permanent employees, in addition to the 2500 workers who are on contract.

Capable of producing 600 TPD (tonnes per day) of finished paper, the high-speed paper machines in the mill are equipped with state-of-the-art automation to ensure output quality. The annual production plan comprises 100 000 MT (million tonnes) of newsprint and 80 000 MT of printing and writing paper. The annual turnover of the company is about 6 billion rupees, which includes 0.8 billion rupees from exports.

Environmental profile

Accredited with ISO 14001 certification, the environmental policy of the TNPL was drawn up and closely monitored by the corporate management. Sustainable development is the thrust area of the policy and any proposal drawn on such lines get full support from the management in the form of financial sanctions. Coordinated teamwork of the upper management and floor executives has been the key to the success of various environmental initiatives. A separate environment wing also exists under the leadership of the General Manager (Environment) that looks after environmental and safety issues.

Following are some of the major commitments fulfilled by the mill in order to reduce pollutants in the manufacturing process.

- Installation of ESPs (electrostatic precipitators) along with boilers, in 1984
- Installation of tall chimneys (86 metres) during 1991 to bring down the ground-level concentration of particulate emission from the multi-fuel boiler
- Installation of ESPs for all power boilers, in 1991
- Investment of 90 million rupees to improve quality of the treated water

- Installation of lime mud re-burning kiln along with ESPs for its stack
- Adoption of a four-stage washing sequence to bring down the chemical load on the environment
- Installation of energy-efficient falling film evaporator.

Further, the company is exploring the possibilities to make the mill more eco-friendly by introducing chlorine-free bleaching of pulp, bio-bleaching of pulp, and less energy-intensive systems.

Based on its continual focus on environment the company has won the following awards and recognition.

- The World Wild Fund for Nature has permitted the TNPL to use its 'panda' logo in TNPL's branded products.
- Loyola Institute of Business Administration conferred on the TNPL the Mother Teresa Award of 'Corporate Citizen' for the year 1999 in recognition of its outstanding social commitment, exploring eco-friendly technology, and being a customer-friendly and community-caring enterprise.
- Two green leaves have been awarded to the company in the Green Rating Project by the Centre for Science and Environment, New Delhi, under the aegis of the United Nations Development Programme for pollution control.
- The TNPL was placed first by the Greentech Foundation, New Delhi, in the 'Indo-German Greentech Environment Excellence Award' for the year 2000/01.

Case study

It is a well-known fact that wood is the best raw material for manufacturing paper and newsprint. But, because of its higher lignin content, the bleaching process generates effluents that are environmentally hazardous. However, at the TNPL, bagasse pulp constitutes 75% of its raw material. The eco-friendly method of paper manufacturing has prevented chopping down of trees in more than 30 000 acres of forest every year, thereby saving 360 000 tonnes of wood annually. The use of bagasse has also reduced the COD (chemical oxygen demand) load in the plant by 60%–70% as compared to wood-based paper manufacturing.

Reducing process pollutants

The TNPL is an integrated pulp and paper unit with two paper machines for producing newsprint and printing and writing paper. Machine 1 is dedicated to producing printing and writing paper at a capacity of 80 000 TPA. Machine 2 has a capacity to produce 100 000 TPA. These paper machines are supported by pulping capacities of 100 TPD of chemical hardwood pulp, 400 TPD of chemical bagasse pulp, and 140 TPD of mechanical bagasse pulp. A *kraft* (traditional) process is adopted for chemical pulping, which is followed by bleaching sequences. Also, mechanical bagasse pulp is bleached to a certain extent using peroxide.

The unit has ensured that no black liquor is sent to the drain in the process. A recovery system has been put in place that has a recovery efficiency of 93%–94%. It consists of the following devices.

- Two black liquor evaporators with 300 m^3/hour water evaporation capacity
- Two boilers totalling to 660 TPD of black liquor solids and handling a causticizing plant of 2000 m^3/day capacity for conversion of black liquor to white liquor
- 170 TPD lime sludge re-burning kiln.



The effluent water treatment plant at the TNPL

Water pollution

The main water pollutants in any paper manufacturing unit are suspended solids, BOD (biochemical oxygen demand), COD, and TDS (total dissolved solids). At TNPL, the entire waste water generated from the mill is segregated and collected in two streams.

1 High BOD and low volume stream (flow: 700 m^3/hour)
2 Low BOD and high volume stream (flow: 1500 m^3/hour)

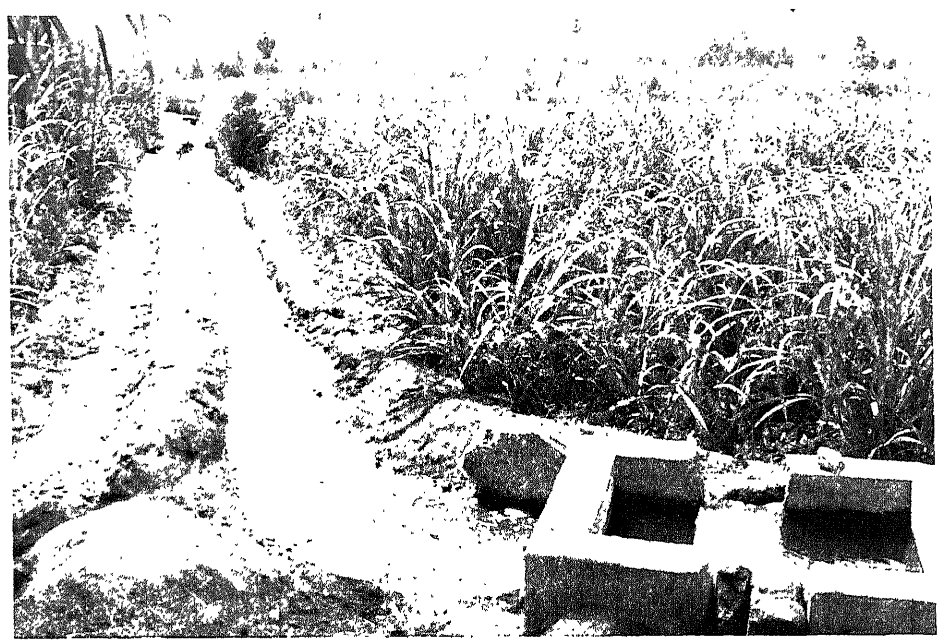
The high BOD stream, consisting of waste water from bagasse storage yards and bagasse preparation plant, is taken through a mechanical bar screen to a bagasse clarifier for settling of suspended solids and then to two anaerobic lagoons in series. The retention time in the anaerobic lagoon is about 12 days. About 80% of suspended solids and 90% of BOD load are reduced through this process. The overflow from the anaerobic lagoon is passed to primary clarifier no. II, the outlet of which constitutes stream A.

The low BOD and high volume stream consisting of waste water from pulp mill, paper machine, and soda recovery plants is also passed through a mechanical bar screen, detritor, sand, grits, etc., and then taken to primary clarifier no. I where the suspended solids are reduced by about 80%. The settled sludge is then taken to the vacuum drum filter for thickening up to a consistency level of 20%. The filter cake is sold as raw material to nearby cardboard mills. The outlet of the primary clarifier no. I constitutes stream B.

The streams A and B are combined and directed to an aeration system consisting of activated sludge/extended aeration basin equipped with 26 fixed surface aerators of 55 kW each. The retention time in the aeration basin is about 24 hours. The overflow from the aeration basin is taken to two secondary clarifiers operating in parallel for settling of the biomass. The sludge from the secondary clarifier is recycled to the activated sludge basin to maintain the MLSS (mixed liquor suspended solids) level of around 3000 PPM (parts per million). The surplus biomass from the secondary clarifier is de-watered in a filter press. The overflow from the secondary clarifier constitutes the final treated effluent of the mill.

The treated effluent water is recycled to various parts of the plant to reduce process water consumption to 95 m^3/MT of paper against previous level of 125 m^3/MT. Control measures are being strictly followed to achieve a target of 75 m^3/MT, which is in line with international standards.

Irrigation of wasteland To fully exploit the treated effluent water, the TNPL has mooted a scheme called TEWLIS (treated effluent water lift irrigation scheme). The area covered under this scheme is about 570 hectares where sugar cane, paddy, groundnut, coconut, and maize are cultivated as the main crops. During the treatment of effluent water, urea and di-ammonium phosphate are added. These have been found to enrich the soil for cultivation. Farmers in the surrounding area who have increased farming activities in the otherwise barren lands are using the treated effluent from the TNPL.



Treated effluent water being used for cultivation of cash crops

Hazardous waste management The solid waste generated from the mill is collected and disposed of with the concurrence of the TNPCB (Tamil Nadu Pollution Control Board), without causing any nuisance to the public. The unit has identified agencies authorized by the TNPCB for the disposal of lubricating and system oils for the quantum of 100 000 kg/year in addition to waste lead-acid batteries.

Air pollution The main air pollutants emitted from the manufacturing unit are SPM (suspended particulate matter), sulphur dioxide, nitrogen oxide, and hydrogen sulphide. The following measures are adopted to mitigate air pollution caused by these pollutants.

- ESPs have been installed in all the five power boilers, for two recovery boilers, and also for the lime kiln.
- A water sprinkler system has been installed and a green belt developed at the coal handling plant to reduce dust emissions during coal handling.
- The TNPCB regularly monitors the ambient air quality and stack. Its report indicates that the air quality around the mill is within the prescribed norms.

- More than 25% of the land has been planted with eucalyptus, subabul, casurina, peltofora, teccoma, tamarind, neem, and coconut trees form a green belt, which acts as a curtain to arrest polluting particulates.

Composting of secondary sludge and pith

In the TNPL mill, laboratory and field studies were carried out using the windrow method to optimize composting process conditions such as time and raw-material ratio. The results indicate that use of waste-activated sludge and bagasse clarifier sludge for composting is beneficial because of the following reasons.

- In the waste water treatment plant, disposal and removal of waste-activated sludge is a serious problem due to its resistance to de-watering. This can be solved permanently by removing waste-activated sludge and bagasse clarifier sludge in 30:70 ratio using vacuum filter.
- The removed filter cake can be converted into humus-rich compost. This reduces the load on the organic solid waste generation, because nearly 45% of the raw materials is oxidized into CO_2 and water and the remaining product, i.e., compost, can be sold as organic manure.
- Partial substitution of organic manure in place of inorganic fertilizers in the agricultural operation improves soil fertility and reduces the pressure on use of inorganic fertilizers.



Composting of secondary sludge and pith

The National Environmental Engineering Research Institute, Nagpur, is carrying out a comprehensive environmental impact and risk assessment as regards the reuse of treated effluent. The TNAU (Tamil Nadu Agricultural University) is also conducting trials to study the impact of treated effluents on land. So far, six trials have been conducted with sugar cane, tapioca, and groundnut. Consequently, the TNAU has recommended continuation of utilization of treated effluent for irrigation, as its characteristics are well within the prescribed norms.

Case study at a glance

The TNPL (Tamil Nadu Newsprint and Papers Ltd) was born out of an innovation by using bagasse instead of wood pulp as raw material for manufacturing paper. Selection of wet piling technology for handling and storage of 0.8 million tonnes of bagasse per annum and formation of a lift irrigation scheme to utilize the treated effluent water for producing cash crops are examples of ideas translated into realities. Selection of activated sludge process for bagasse effluent and installation of a lime kiln to handle the lime sludge solid waste resulted in better solid waste management.

Paper manufacturing involves high expenditure on resources such as energy and water. The TNPL has taken effective measures to reduce the use of these resources in the production process and has shown remarkable environmental performance.

- The TNPL is the largest eco-friendly paper producer in India utilizing bagasse as raw material. Its most significant contribution is that it conserves about 360 000 tonnes of wood annually, thereby saving 30 000 acres of forest from being denuded.
- In terms of handling of liquid effluent, the TNPL's standards are lower than that of the prescribed limits.
- At present, its stock of solid waste such as effluent sludge, pith, and fly ash is small as compared to the magnitude of the operation and the resultant waste.
- The company initiated action to recycle treated effluent water to various parts of the plant to reduce process water consumption to 95 m^3/MT of paper as against previous level of 125 m^3/MT. Strict in-plant control is being maintained to achieve a target of 75 m^3/MT, which is in line with international standards.
- The distribution of treated effluent water for irrigation of wastelands through the TEWLIS scheme has turned the barren land to fertile soil for cultivation of cash crops like sugar cane and groundnut.
- To conserve energy, power, and steam, stage-by-stage modifications were made in the distribution plate of the falling film evaporator.
- The entire effluent stream is diverted into an activated sludge lagoon to bypass the old lagoon, thereby stopping four aerators of 55 kW.

CASE STUDY

19 Tata Refractories Ltd

Background

The TRL (Tata Refractories Ltd), formerly known as Belpahar Refractories Ltd, was established in 1958. It was jointly promoted by Tata Steel and Didier Werke AG of Germany, one of the world's largest refractories manufacturers, as its technical collaborator with financial participation. At present, Tata Steel is the major shareholder and the TRL is the number one refractories manufacturer in India.

The TRL has a comprehensive range of products of all grades and shapes required to meet the ever-growing needs of the core industries such as steel, copper, cement, aluminium, and petrochemicals. The product range comprises different qualities like basic, silica, high alumina and dolomite bricks, flow control products, and wide varieties of monolithics. The company's entire range of products is certified to ISO 9002. The TRL also offers total refractories solutions to its customers.

The annual installed capacity of the plant is 123 000 MT (million tonne) and the annual turnover is about 2.47 billion rupees. At present, total number of employees working in the company is 1577. The main unit is located at Belpahar, Orissa, and the sintering plant producing dead burnt magnesite is located at Karuppur, Tamil Nadu. A small quantity of monolithics is also produced in the Karuppur plant, which contributes to about two per cent of total sales of the company. Besides, about seven per cent of the total sales is contributed by franchisee operations located at Jamshedpur, Jharkhand. These operations are basically conversion plants where processed raw materials from the TRL are converted into final products before despatching to customers.

Environmental profile

It has an environmental laboratory at Belpahar for regular monitoring of various air and water pollutants. The TRL has won many awards such as the Best Environment Management Company Award for 1997 and the Best Occupational Health Care Award for the years 1993, 1997, and 2000 from Orissa government.

The TRL has also formulated an environmental policy. Its environment management programme is an ongoing process and it has also undertaken other important programmes, as listed below.

- Installation of a state-of-the-art ESP (electrostatic precipitator) in the dolomite rotary kiln at Belpahar
- Installation of state-of-the-art cassette-type reverse air-filter in rotary kiln at Karuppur
- Replacement of inefficient mechanical shaker-type bag filters with latest pulse jet bag filters
- Installation of settling tanks and filter beds for treatment of waste water
- Development of green belt around the factory and colony.

The TRL's community development activities aim at improving the quality of life in the areas of community health, environment protection, literacy drive, and economic upliftment. A full-fledged community development and social welfare department exists in the company for this purpose with an earmarked budget allocated to it.

The TRL has undertaken various environmental development programmes.

- Raising and planting of different varieties of trees with the help of local residents
- Promoting the use of non-conventional energy such as solar cookers and solar lanterns
- Providing safe drinking water facilities
- Improving sanitation standards of villages by providing Barpali-type latrines, bleaching powder, etc.
- Enhancing environmental awareness through classes, exhibition, and training programmes

Case study

The TRL's Belpahar unit is the main plant contributing to around more than 90% of the total turnover of the company. This plant produces all grades of refractories bricks and monolithics as described earlier. The refractories manufacturing process involves grinding/crushing, conveying, and handling of various sizes of minerals.

Fighting quartzite dust

The SPM (suspended particulate matter) is the main air pollutant from the plant, which is generated during crushing, grinding, mixing, and handling of different materials. A number of bag filters and one ESP have been installed to abate dust pollution. Besides, humidifiers are placed in strategic locations to suppress fugitive dust emission. Sweeping of the road and disposal of dust materials from pits/floor are done through mobile vacuum cleaners. The effectiveness of these programmes are assessed through regular monitoring of work environment, stack emission, and ambient air quality.

Out of the various minerals handled, the quartzite dust is most harmful to human health. Employees who are working in the silica plant are continuously exposed to silica (quartzite) dust and, over a period of time, the dust inhaled by them gets deposited in their lungs causing pneumoconiosis, specifically known as silicosis.

Earlier, at the TRL, cases of silicosis were reported and it was realized that the measured dust level in the workzone was very high, i.e. to the tune of 30–40 mg/m^3, while the Inspectorate of Factories prescribed 7.5 mg/m^3 as the norm.

The company had installed three mechanical shaker-type bag filters (Table 1) connected to various grinders and crushers, vibrating screens, and bucket elevators that handled silica dust to arrest the floating dust particles. However, over a period of time, these filters were ineffective in reducing dust pollution below a certain level.

Then, the TRL decided to initiate appropriate measures to further reduce the workzone dust level in the silica department. The TRL studied and evaluated various options to select the optimum pollution control system that would ensure workzone dust level below 2 mg/m^3.

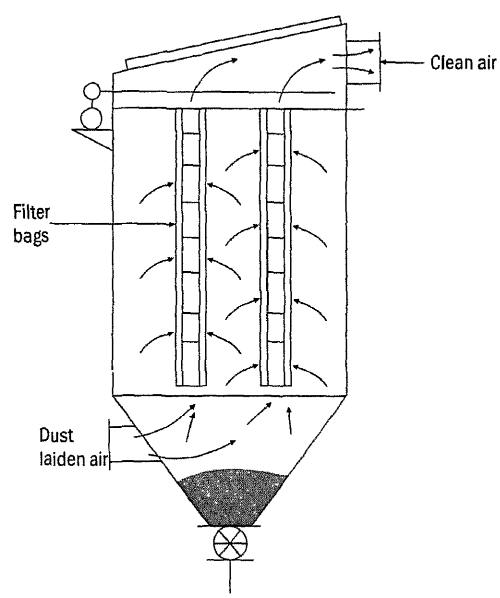
Table 1 Performance of mechanical shaker-type bag filters

Item	*Requirement*	*Performance of three filters put together*
Volume of air handled	82 000 m^3/hour	56 000 m^3/hour
Velocity of air in the duct	18–22 m/s	10–11 m/s
Suction at fan inlet	> 300 mm WG	200 mm WG
Connected electrical load	Not applicable	237 kW
Annual electrical energy cost	Not applicable	3.4 million rupees

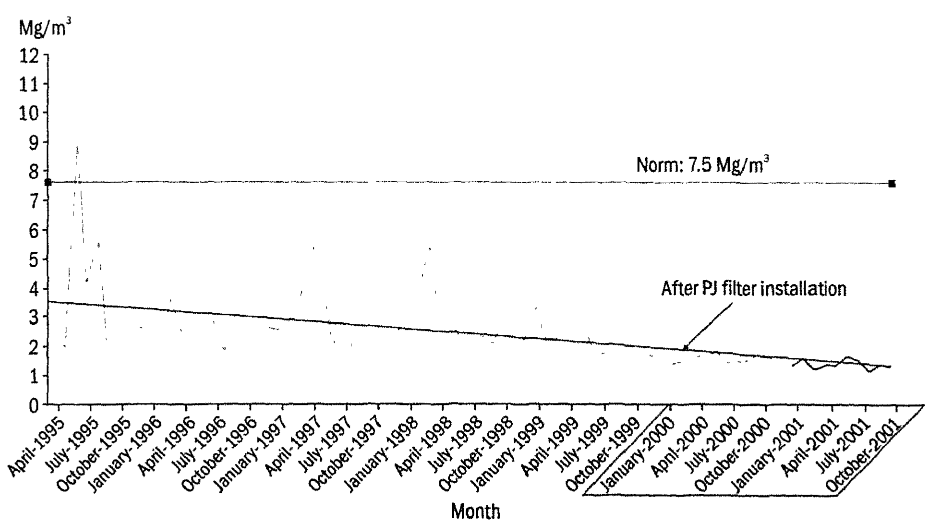
Based on the requirement of the air volume to be handled to ensure dust-free environment, two state-of-the-art pulse jet filters replaced the existing three mechanical shaker-type bag filters (Table 2). The new filters, installed in 1999, not only reduced pollution in the workzone but also led to electrical energy conservation. In addition, the project helped in minimizing/eliminating cases of silicosis in the long run. By reusing the dust collected by the filters in the manufacturing process, its raw material requirement also reduced.

Table 2 Performance of pulse jet filters

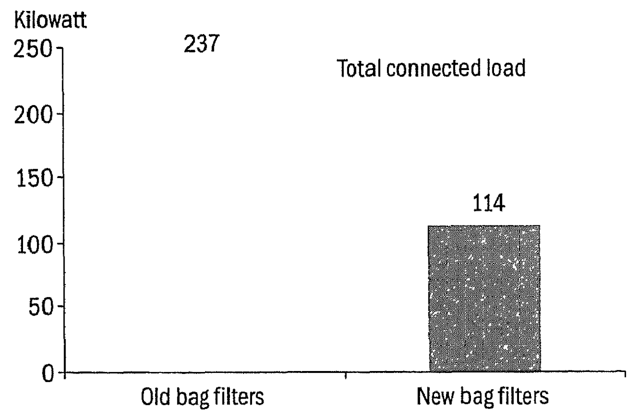
Item	*Requirement*	*Performance of two new filters put together*
Volume of air handled	82 000 m^3/hour	82 000 m^3/hour
Velocity of air in the duct	18- 22 m/s	18-22 m/s
Suction at fan inlet	> 300 mm WG	320 mm WG
Connected electrical load	Not applicable	114 kW
Annual electrical energy cost	Not applicable	1.72 million rupees



Sketch of pulse jet filter



Trend of workzone dust level in the silica plant



Total savings per annum: Rs 1.68 million
Total investment made: Rs 3.60 million

Electrical energy saving achieved in this project

The above project was undertaken as part of a long-term strategy to replace the old mechanical shaker-type bag filters in the entire plant phasewise. Though the shaker-type filters were able to meet the norms, the above drive was taken up as a part of the company's commitment to continually improve its environmental performance. Moreover, the issue of occupational health hazard was associated and the TRL proactively implemented the project to ensure prevention of silicosis cases among its employees.

Besides, due to effective running of the pulse jet filters, the stack emission was much below the prescribed norm (around 40–50 mg/m^3 against the limit of 150 mg/m^3), thus ensuring that no pollutants were emitted. Recurring savings on account of electrical energy and reuse of collected silica dust reduced the cost of production and its benefit was passed on to the customers.

Water pollution

Refractory manufacturing being generally a dry process does not generate any waste water. Waste water is mainly generated from canteen, floor-washings, etc. The main pollutants are total suspended solids and oil and grease. Floor-washings pass through oil separation pits before leaving factory premises.

This waste water mixed with domestic waste water passes through sedimentation tanks of adequate capacity followed by filter beds. The outgoing water from these systems meets the most stringent pollution control norms and is finally discharged onto the land. The waste water quality is regularly monitored to ensure the effectiveness of the above systems. The domestic sewage water is treated in septic tanks followed by soak pits.

Hazardous waste

The major hazardous wastes generated in the plant are coal tar, used oil, etc. Coal tar generated from gas producer are stored in pits with impervious lining and subsequently sold to outside parties who have hazardous waste authorization from the State Pollution Control Board. The used oil is collected in drums and sent for recycling to authorized party. The recycled oil is then reused.

Solid waste The major solid wastes that are generated in the plant include rejected bricks, metallic scraps, filter dust, coal dust, and coal ash. Most of the rejected bricks and filter dust are recovered, recycled, and reused. The rest is used as landfill inside the factory premises. The metallic scraps, coal dust, and empty polythene bags are sold to outside parties.

Resource conservation The floating dust collected from the processed raw material by different pollution control equipment is reused completely in the manufacturing process, thus saving costly raw material. The TRL has identified energy conservation as one of its thrust area and a number of operational and technological initiatives have been undertaken during recent years to save petroleum fuel, electricity, and coal.

Case study at a glance

The refractory industries, in general, face the challenge of hazardous dust pollution. Workers in plants handling quartzite to make silica refractories are susceptible to silicosis. However, installing pollution control equipment is highly capital-intensive, since there is no apparent return on investment from such projects. The commitment of TRL's management towards cleaner technologies has provided resources and solutions to potential environmental hazards.

- One electrostatic precipitator and a number of bag filters have been installed at strategic locations in the plant to abate dust generation due to crushing, grinding, mixing, and handling of different materials.
- The introduction of two state-of-the-art pulse jet filters resulted in reducing pollution remarkably in the workzone while leading to energy conservation. The stack emission is now 40-50 mg/m^3 against the permissible limit of 150 mg/m^3.
- Waste water in the plant is treated by following the most stringent pollution control norms.
- Hazardous waste like coal tar is collected and sold to parties who have authorization from the State Pollution Control Board.
- Used oil is collected and sent for recycling.
- Solid wastes such as rejected bricks and filter dust are recovered, recycled, and reused.

Process Improvement

CASE STUDY

20 Grasim Industries Ltd (Staple Fibre Division)

Background

Grasim's core unit – the VSF (viscose staple fibre) plant at Nagda, Madhya Pradesh – was set up in 1954. Its capacity, initially 5500 TPA (tonnes per annum), is now 122 275 TPA. It has grown to be the largest VSF unit in India.

VSF is an extremely versatile textile fibre with characteristics similar to cotton. Next to cotton, VSF is the best man-made fibre with durability and lustre. It can be used in blends with polyester and other synthetic fibres. Its moisture absorption property renders it ideal for sub-tropical and tropical climates like India's.

Unique in its wide range of VSF to suit customers' varied requirements in terms of length, denier, and colour, this unit is the largest producer of spun-dyed and speciality fibre in the world. Spun-dyed VSF allows the yarn to be very even and colour-fast.



Grasim's Nagda plant that is IS/ISO 9002, 14001, and OHSAS 18001 certified

Environmental profile

The management is focused on sustainable development. In the context of industrial activity, it would require saving resources in the production process and treating discharges and emissions to render them harmless. At Grasim, a cell at the highest level monitors these activities. At the corporate level, the environment and technical cells periodically audit such activities and also formulate projects to develop technological alternatives or substitutes. All initiatives taken for environmental preservation and protection are published in the house magazine to make the employees aware and to motivate them to do better.

The environment and technical cells deal with periodic audits related to resource conservation and formulation of projects for upgrading environmental facilities, besides technology and innovative measures for alternative use/substitutes. The environment cell promotes recycling of chemicals and elimination or minimization of waste at source in different sections of the plant and in various manufacturing stages. There has been continuous

reduction in the consumption of raw materials, chemicals, steam, power, and water year after year through adoption of cleaner technologies and better systems.

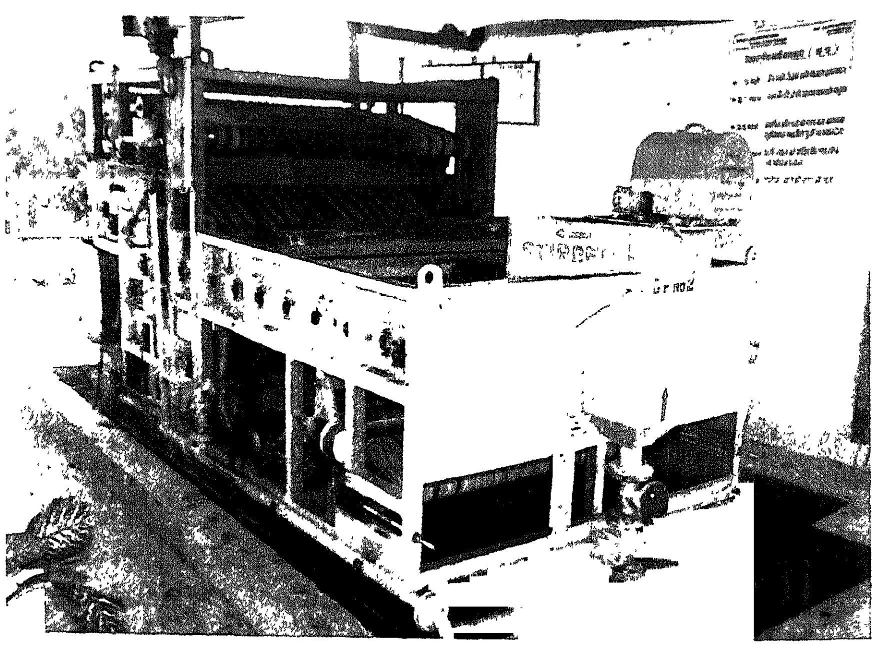
Grasim's approach for meeting and bettering norms stipulated by pollution control authorities can be summed up as follows.

- Periodic audits to bridge the gap between standards and actual consumption of various raw materials, chemicals, and water
- Elimination of non-value-adding processes and generation of wealth from waste
- Productivity improvement through change in equipment design, optimization of process parameters, and adoption of cleaner technologies
- Propagation and implementation of an environment management system up to the grass-roots level through campaigns and training
- Formulation of mutual aid schemes involving nearby industries for environment- and safety-related issues
- Promoting paperless culture in the organization.

Case study

Grasim follows a four-pronged strategy to manage environment better—continually innovate better ways to use technology, recover and recycle waste, conserve energy, and treat inevitable waste. Rayon-grade pulp is steeped in caustic soda solution and excess lye is drained in slurry presses to obtain a mat of alkaline cellulose. After shredding, alkaline cellulose is reacted with carbon disulphide and then dissolved immediately in diluted caustic soda solution to give viscose that is deaerated, filtered, and ripened before extrusion through spinnerettes into a spinning bath containing sulphuric acid, sodium sulphate, and special additives. Cellulose is regenerated in the form of fine filaments and sodium sulphate is produced with the liberation of carbon disulphide, part of which is recovered for reuse. The filaments are cut into the required staple length, washed, desulphurized, bleached, soft finished, and dried to obtain VSF.

No production process can convert the entire input resources into end products. Certain minimal amounts of inputs are bound to get released into the environment as pollutants, treatment of which (to render them harmless)



Sludge dewatering unit (belt press)

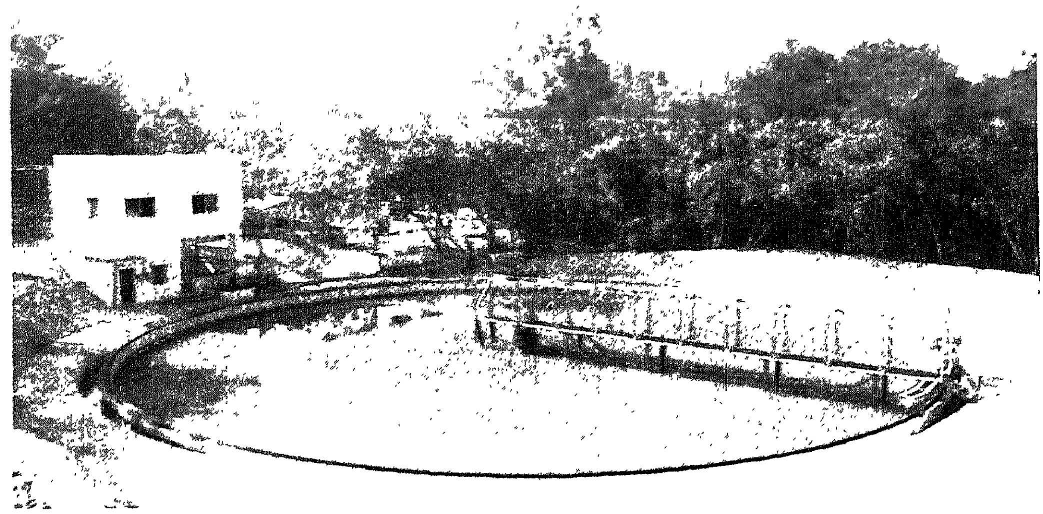
entails further consumption of resources. Thus, higher consumption of resources in the production process manifests itself in higher wastage, not only due to direct loss in production resulting in pollution, but also on account of treatment of such pollution. An effective strategy for sustainable development serving the cause of economic progress has to focus on innovative upgradation of technology. Grasim's staple fibre division has adopted just such a strategy.

Grasim uses zinc-free process technology to manufacture VSF. Because this major pollutant (zinc) has now been eliminated, the problems of treating waste water and managing and handling hazardous waste are now far fewer. Also, the sludge from the effluent treatment plant is no longer hazardous. Grasim has developed a technology to dry and burn it in its boilers. These boilers, which otherwise use coal, burn over 90% of the solid waste generated in the plant, including all the sludge.

Grasim sponsors research activities at the Birla Research Institute of Applied Sciences, Nagda, to develop a solvent-spinning technology. This would produce cellulosic fibre using less chemicals, requiring a shorter process, forming no hazardous by-products, and would have commercial advantages over the currently-used viscose process.

- Its anaerobic filter treatment plant reduces the biochemical oxygen demand in dairy effluent by 80%–90%. This improves the quality of biogas generated.
- Grasim utilizes 80%–90% of the fly ash it generates to manufacture bricks and cement. This minimizes disposal problems.
- It recovers sodium sulphate, a by-product of VSF and 40%–50% of the total input of carbon disulphite during regeneration of VSF.

To reduce water usage, it has redesigned equipment, increased throughput, and recycled various waste streams to the maximum extent possible. From 275 m^3/tonne fibre about 18–20 years ago, its consumption has now come down to 60 m^3/tonne fibre. It has introduced multi-stage flash evaporators, acid absorption crystallizers, multi-effect anhydrous evaporators in its plants, and is now using half the steam it used to. It also uses steam instead of water in cutter ventures.



Case study at a glance

- Grasim follows a four-pronged strategy to manage environment better: (1) continually innovate better ways to use technology, (2) recover and recycle waste, (3) conserve energy, and (4) treat inevitable waste.
- The company uses zinc-free process technology to produce viscose staple fibre.
- As a result of elimination of the main pollutant, zinc, the problems of treating waste water and managing hazardous wastes are fewer.
- To reduce water usage, the company has redesigned equipment, increased throughput, and recycled various waste streams.
- The company uses 80%–90% of the fly ash it generates to make bricks and cement.

CASE STUDY

21 Hindustan Petroleum Corporation Ltd

Background

The HPCL (Hindustan Petroleum Corporation Ltd) came into being in mid-1974 after the takeover and the merger of the erstwhile ESSO and Lube India undertakings. Caltex was taken over by the Government in 1976 and subsequently merged with the HPCL in 1978. The Kosan Gas Company, the concessionaires of the HPCL in the domestic LPG (liquefied petroleum gas) market, was taken over and merged with the HPCL in 1979. The HPCL is thus a merger of four different companies across four points in time.

The HPCL is a public sector undertaking and the second largest integrated oil company in India. Its annual turnover is over 47 billion rupees. It employs over 11 500 people. It has two refineries producing a wide variety of petroleum products (fuels, lubricants, and specialty products): one in Mumbai (west coast) having a capacity of 5.5 MTPA (million tonnes per annum) and the other in Visakhapatnam (east coast) with a capacity of 7.5 MTPA.

Environmental profile

As a corporate citizen, the HPCL is committed to environment protection and constantly endeavours to ensure that the increasing scale of operations does not lead to environment degradation. The environment policy adopted by the corporation commits it to conduct all its operations in such a way as to be compatible with the environment. Extensive green cover has been provided in HPCL's refineries and continuous efforts are being made on this front in areas surrounding the refineries.

The HPCL has environment, health, and safety policy at the company level and has a separate environment department. The initiatives taken by the HPCL towards clean environment includes

- desulphurization facilities for high speed diesel;
- re-circulatory system for cooling water;
- sulphur recovery units;
- continuous stack monitoring system; and
- use of pipelines for product transfers.

The main air pollutants emitted from the refinery are as follows.

Table 1 Controlling pollution

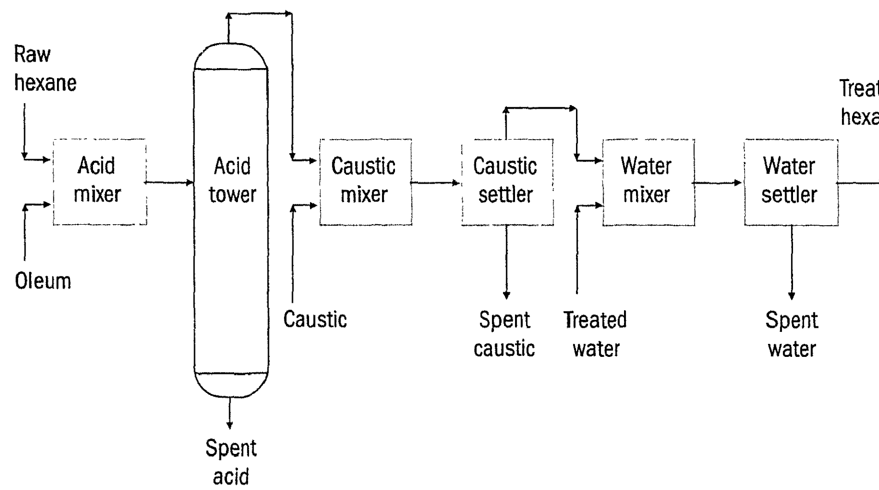
Pollutants	***MPCB* limits***	***Concentration of pollutants* (mass/volume)**
Sulphur dioxide	13.5 T/day	11.5 T/day
Oxides of nitrogen	6.5 T/day	4.5 T/day
Carbon monoxide	0.5 % V/V	< 0.5 % V/V
Suspended particulate matter	150 mg/Nm^3	115.8 mg/Nm^3

*MPCB - Maharashtra Pollution Control Board

The amounts of pollutants released are all within limits and there is 100% compliance. The major water pollutants emitted are sulphides, phenols, total soluble solids, and oil and grease.

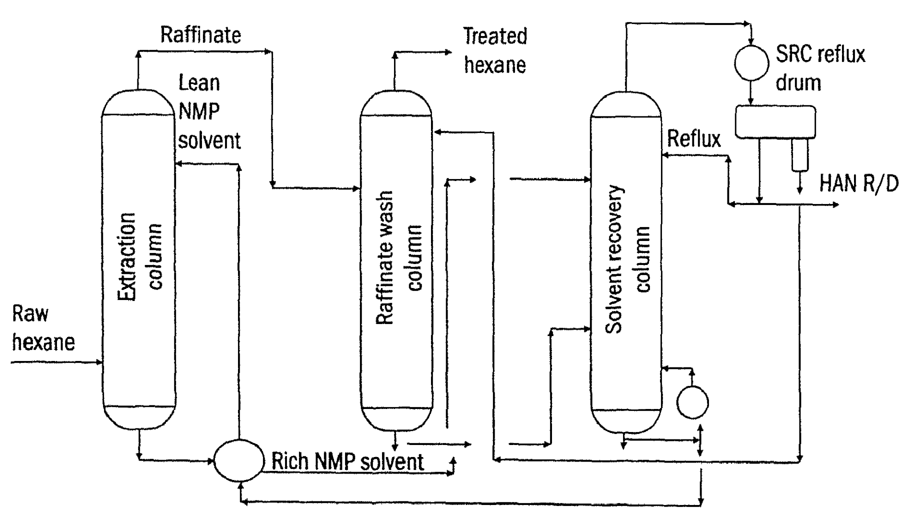
Case Study

The HPCL had installed a hexane manufacturing unit at its Mumbai refinery in 1969. This unit was designed to produce hexane at a range of 63–69 °C with aromatics content of less than one per cent. At that time, the conventional oleum treatment process was used to remove the aromatics from raw hexane. The process generated dilute sulphuric acid that had aromatic compounds. This corroded plant and machinery in the plant was causing leaks, leading to frequent shutdowns. Moreover, the acid would mix with the hexane. The hexane would then need to be washed with caustic so that it might be neutralized, then washed with water, and subsequently dehazed. Besides, removing the aromatic compounds would reduce the hexane produced by three per cent.



Treatment of hexane using oleum

The HPCL then decided to use a solvent that would not cause these problems and would also be ecofriendly. They chose sulpholane—the best solvent for pure aromatics production. Later, they switched to NMP (n-methyl pyrrolidone)—the best solvent for food-grade hexane production.



Treatment of hexane using NMP (n-methyl pyrrolidone)

The process design and engineering was in an advanced stage when the decision for the switchover was taken. Necessary modifications in the process design and engineering were carried out in-house by the HPCL to accommodate NMP as solvent in place of sulpholane. The following table proves the superiority of using NMP over the chemicals used earlier.

Table 2 Comparison of solvents used in refineries

Property	*Oleum*	*Caustic*	*N-methyl pyrrolidone*
Corrosive class	8	8	No corrosive rating
Hazardous waste ID no.	16	16	N.A
pH	<1	13-14	7.7-8.0
NFPA health rating	3	3	2
Reactivity rating	2	2	0

In recognition of these efforts, the HPCL Mumbai Refinery was conferred the prestigious CSIR (Council of Scientific and Industrial Research) Technology Award for 2001 and Golden Peacock Award 2001 in the category of Innovative Products/Services.

Typically, any refinery looking for process improvement would have restricted its choice to well-established and commercially proven technology. However, in this case, the HPCL went on to choose a path of indigenous process technology development.

The HPCL also adopted an innovative approach by changing a major and significant parameter like the solvent. Normally, a solvent change in a plant is done after enough experience has been gained on the plant with a previous solvent. The operating experience of the plant with the old solvent is essential and cannot normally be substituted by calculation. However, the HPCL process engineers, with the help of advanced stimulation packages, were successful in precisely mapping the gap between installed facilities and that required for the new process. This mapping helped in determining the modifications required in the installed facilities and also helped in drawing up the facilities for new equipment/facilities required.

Significant environmental benefits

The project has been implemented with a view to replace a solvent like oleum, which is environmentally unfriendly with a solvent like NMP, which is environmentally very friendly. The challenge has been essentially in getting deeply involved in each stage of technology development right from pilot plant studies to process package development and process commercialization. The challenge was more exciting because of the fact that all the activities related to process package development and commercialization of the NMP hexane technology was handled by the HPCL personnel without any assistance from any external agencies. Since such a plant was being put up for the first time in the world, the HPCL personnel had to depend on their own skills and experience.

The NMP hexane plant has shown consistent performance since commissioning and hence it can be concluded that the objective of replacing oleum with a more environmentally friendly solvent has been achieved. In fact, the overall efficiency is much higher and atmospheric pollution has been reduced.

The project has demonstrated the potential of collaborative projects undertaken by industry with R&D institutions and the success of the project can easily prove to be a model for other industries/businesses.

Case study at a glance

The company has been controlling air and water pollution in various ways. In order to reduce pollution and hazardous waste, the company took a major decision in changing the solvent used in hexane manufacture. The complete complex process of manufacture with the new solvent was taken up by the HPCL (Hindustan Petroleum Corporation Ltd) in-house. The new technology using n-methyl pyrrolidone as solvent has been commercialized by the HPCL Mumbai refinery and the plant is the only one of its kind in the whole world

CASE STUDY

22 Shree Cement Ltd

Background

Designated as a four-star company in the survey of cement factory performance conducted by Whitehopaleman, UK, and *International Cement Review*, the SCL (Shree Cement Ltd) operates two dry process plants. With a capacity of 0.6 million tonnes a year, the first unit was commissioned in May 1985, near Beawar, Rajasthan. Its installed capacity was raised to 0.76 million tonnes during 1993. In 1997, the SCL commissioned its second unit with an installed capacity of 1.24 million tonnes of cement a year, under its capacity enhancement programme in 18 months. The capacity utilization has been maintained at more than 100%.

The SCL produces ordinary portland cement, ecofriendly portland pozzolana cement using fly ash, and railway sleeper-grade cement. The steady increase in production is depicted in Table 1.

Table 1 The SCL's increase in production

Particulars	1998/99	1999/2000	2000/01
Cement production (MT)	2.04	2.31	2.38
Sales - clinker and cement (MT)	2.26	2.43	2.58
Energy consumption			
Power (kWh/T cement)	79.00	75.00	78.00
Coal (percentage of clinker)	12.79	12.34	9.47
Sales (million rupees)	4421.50	4845.60	5561.20

Environmental profile

The SCL has drafted an explicit environment policy as a reference point for the company's operations. The policy is widely displayed within the organization for collective information and action. An environment improvement cell monitors environmental conditions within the SCL and, whenever required, suggests remedial measures. Maintenance and upgradation of efficient pollution control equipment have helped the company in controlling



The Shree Cement Ltd plant at Beawar, Rajasthan



To mitigate greenhouse gas emissions, Shree Cement has planted trees in the plant's vicinity and along the road

emissions well below the permissible limit. For mitigation of greenhouse gases, trees have been planted on a large scale. Pollution due to vehicle movement is controlled by construction of concrete roads in and around the plant.

In addition to its responsibilities towards the environment, it also takes its corporate social responsibilities seriously.

The World Environment Day is celebrated every year to improve awareness among its staff. To keep abreast of latest information on clean development mechanism, the SCL's executives attend various seminars and workshops.

The main air pollutant emitted during cement manufacture is SPM (suspended particulate matter). The SCL, which uses dry process technology for cement production, has installed efficient dust-collecting systems across the various dust-generation points (Table 2).

Table 2 Dust collecting systems

Plant section	*Equipment (Unit I)*	*Equipment (Unit II)*
Raw mill and kiln circuit	ESP (electrostatic precipitator)	ESP
Clinker cooler	ESP	ESP
Cement mill	Bag filter	ESP
Coal mill	Bag filter	Bag filter
Venting at various locations	Bag filter	Bag filter
Crusher	Bag filter	Bag filter

Special attention is given to suppressing fugitive dust being generated at various transfer points by spraying fine droplets of water and installing 22 bag filters and 20 bag filters in Units I and II, respectively. In the last three years, SPM from stack emissions has reduced (Table 3).

Table 3 SPM from stack emissions (mg/Nm^3)

Year	*Unit I*	*Unit II*
1999	138.96	123.16
2000	137.28	70.46
2001	120.72	65.10



A reservoir at the plant supplies water for cooling

By reducing electrical and thermal energy, minimizing fly ash, and optimizing process parameters, the greenhouse gas emissions are controlled.

There is no water pollution during the dry process technology of manufacturing cement. Water is used for cooling the plant equipment and then recycled. It is also used for spraying in the raw material yard, crusher hopper, and roads.

For disposal of medical waste, the incinerator developed in-house is used. Proper attention is paid to hygiene at the plant and the colony to avoid spread of communicable diseases.

The SCL's staff keeps up with latest technological developments, innovations in the field of cement technology, such as raw mix design, refractory, pollution control, energy conservation, use of alternative waste-derived fuels such as tyre and petroleum coke through regular contact with main plant designers, suppliers, and other consultants. Use of spaces under conveyor belts, avoiding idle running, minimum use of transport for feeding raw materials, and use of energy- and fuel-savers are some examples of how the SCL tries to conserve natural resources.

To increase energy savings, the SCL has modified and upgraded its systems to improve the performance of equipment such as high-efficiency dynamic separator, sepax separator, low pressure cyclone, installation of DD (de-dusting) cone, and IKN-kids system in cooler first grate.

Utilization of industrial wastes like mill scale in the manufacture of clinker has resulted in reduction of high-grade limestone. The use of fly ash for the manufacture of PPC has resulted in electrical and thermal energy savings, and raw material savings. Despite several associated problems with using pet coke in cement plants, the SCL's R&D Centre has made inroads to use pet coke as a substitute for coal.

Case study

Cyclone is the most commonly used equipment for de-dusting and can be operated between 0.1 and 100 bar pressure and temperature well over 1000 °C with a collection efficiency of 80%–85%. Dust-laden gas enters the cyclone tangentially and moves in a spiral motion inside the cyclone. Due to centrifugal force, dust particles come in contact with the cyclone wall, lose momentum and collect at the bottom of the cyclone. The number of spirals is

short and they are short-circuited, which causes turbulence while exiting through conventional cylindrical dip tube. This results in high pressure drop across the system. Due to short spiral motion of gases and the turbulence in the cyclone, there is always some entrainment of collected dust in the clean gas. This decreases the collection efficiency of the conventional cyclones.

The SCL felt that increasing the spirals and smooth exit of gases from dip tube could improve separation efficiency. So they designed a dip tube bottom to match the spiral size, allowing gases to exit smoothly without any turbulence and separate from dust particles. The dip tube's bottom has a spiral opening to match the spiral path of gases in the cyclone, which is calculated as per the velocity of gases inside the cyclone.

This newly designed system called the DD cone is based on the principle of agglomeration of smaller particles to bigger clusters by changing the flow direction. The SCL first installed a DD cone inside the raw mill conventional cyclone. This resulted in a spiral motion above the collecting area of cyclone. Thus, the dust-free gas travels smoothly, which results in lower pressure drop. Due to blind bottom, there is no spiral motion of gas in the collecting portion of cyclone, ensuring dust collection efficiency of 95%–99%.

The DD cone is an attachment with the central tube extended towards bottom of cyclone, tailor-made to guide the exit gas flow and keep away the segregated particles, which depends on the dimension of annular space.

Box 1 Normal cyclone versus cyclone with de-dusting attachment

	Normal cyclone	*Cyclone with de-dusting cone*
1	Gas spiral in the lower part becomes weaker as it travels downwards and also partial short-circuiting of exit gas takes place, which results in lower separation efficiency.	Due to its specially designed shape, strong downward spiral in lower portion of cyclone is maintained and also guides the exit gases in a smooth upwards spiral, which improves the separation efficiency of cyclones as well as reduces the pressure drop by avoiding the short-circuiting of exit gases.
2	There is a return spiral from the cyclone bottom, which carries back the parts of collected dust particles.	Due to its specially designed blind bottom, the formation of exit return spiral from cyclone bottom is avoided, which prevents carrying back of collected dust.
3	Exit gases carry fine particles away.	Due to its conical shape and properly guided strong upward spiral of exit gas, further separation of fine particles takes place.

Scientific approach

During the development of the DD cone, parameters such as the gas temperature, stake pressure, dust load, gas flow, dimensions, cross section, particle size distribution, and nature of gas were considered. Other details that were taken into account while designing the DD cone were as follows.

- Particle size distribution of collected dust
- Whether the cyclone has any refractory or metallic lining on the cyclone body
- Whether the cyclone has any other internal fittings
- Details of exact application like raw mill, cement mill, etc.
- The exact location for the measurements
- Drawing of the cyclone.

After proper designing of a DD cone for a specific cyclone, it is attached to the dip tube.

Development difficulties

The development of the DD cone is new in the area of energy conservation and environment improvement. Therefore, it did have problems in the beginning, but due to systematic approach and dedicated teamwork, the SCL was able to overcome these problems.

- Dust accumulation was observed in the surface of the DD cone. The surface was then modified to eliminate dust accumulation and resulted in smooth operation.
- When installed in pre-heater twin cyclone where temperature is considered to be higher as compared to normal conventional cyclones, pressure drop was found to be increasing and no reduction observed in the amount of return dust. To overcome this, the SCL's R&D Centre modified DD cone, to have three faces instead of the earlier two.

Applications and results

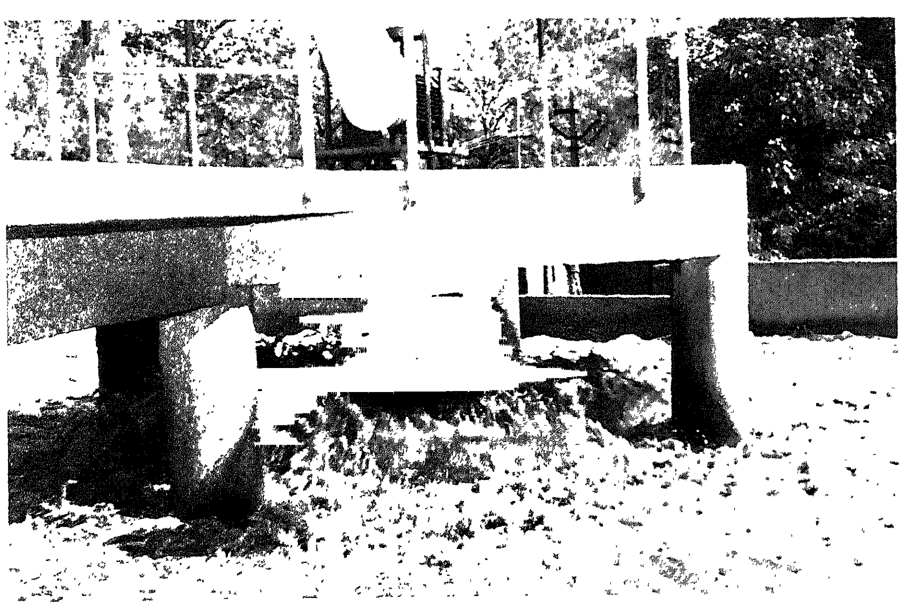
The DD cone has been installed successfully in the SCL's cement plant in raw mill, cement mill, coal mill, and clinker cooler cyclones. It has also been installed in pre-heater top cyclone. Results indicate that it can be installed in every cyclone with redesigning of dip tube with de-dusting cone.

Resource conservation

The cement industry contributes to greenhouse gases emissions, especially CO_2 emissions and SPM (suspended particulate matter) into the environment. It is clear that the installation of the DD cone at various cyclones and pre-heater top cyclone has resulted in

- reducing dust generation,
- reducing power consumption due to reduction in pressure drops,
- improving the collection efficiency leading to conservation of natural resources and improved environment, and
- reducing the maintenance cost due to reduced wear and tear caused by return dust in exit gas.

However, one of the most important achievements of the development of the DD cone is in energy conservation and reduced annual costs (Table 4).



The effluent treatment plant at Shree Cement Ltd

Table 4 Savings achieved through energy conservation and reduced costs

Area / section	Yearly savings achieved Million kWh	Million rupees
Raw mill	0.25	0.80
Cement mill	0.14	0.44
Cement mill pre-collector	0.07	0.22
Clinker dust collector	0.03	0.11
Pre-collector after coal mill	0.05	0.15
Cement mill II	0.08	0.29

The total expenditure for this facility was a mere 0.61 million rupees. Similar attachment has been made in other cyclones as well as preheater top cyclones. These have resulted in conservation of natural resources and lesser environmental hazards. Better heat transfer efficiency has resulted in thermal energy saving and thus lower emission of greenhouse gases.

Following the encouraging results, DD cones were installed at 24 other places. A few of them are vertical roller mills, cement mills, coal mills, and clinker cooler cyclones of both the units.

Successful testing of the DD cone led to attempts by its R&D Centre to achieve still better results, especially in the main cyclone preheater, which shall also lead to enhanced clinker production by reducing return dust with existing set-up. After exhaustive studies, the DD cone was modified and installed in top cyclones of both the units.

According to company, such a project involves study of collected data, measurements, and designing.

Case study at a glance

- The SCL (Shree Cement Ltd) has a well-defined environment policy.
- To reduce SPM (suspended particulate matter) emission, the SCL uses electrostatic precipitators and bag filters at its two units.
- To mitigate emission of carbon dioxide, the SCL has planted trees on a large scale in its vicinity.
- To improve process and reduce SPM, the company has modified cyclones and fitted them with de-dusting cones.
- The company took a calculated risk in installing de-dusting cones, but the venture paid off with a total yearly saving of over 1.7 million rupees.

CASE STUDY

23 Sundaram Brake Linings Ltd

Background

The SBL (Sundaram Brake Linings) Ltd, a part of the TVS (T V Sundaram Iyengar & Sons) group of companies, manufactures and exports friction materials like brake linings, moulded clutch facings, woven clutch facings, flexible rolls for bonding, and bonded brake shoes. The SBL also manufactures products in asbestos and asbestos-free grades. It exports 50% of its production.

The company is multi-locational and has three plants. One is at Padi, Chennai, which was started in 1976, and has a capacity of 450 MT (million tonnes) per month. The other two are at TSK Puram near Madurai, Tamil Nadu, started in 1984 and 1995 respectively, both having capacity of 225 MT per month.

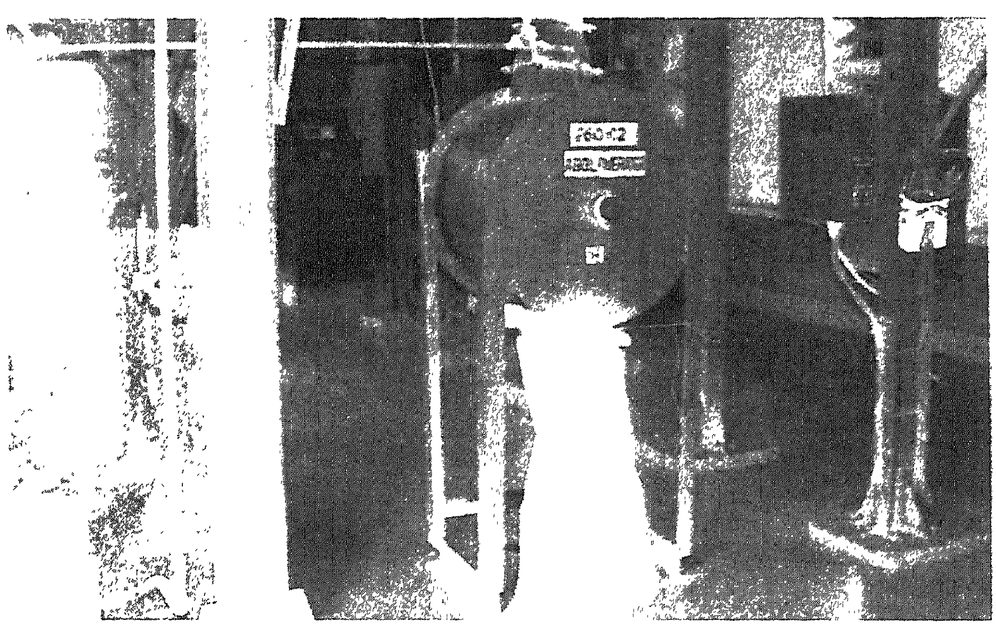
The company has undertaken a 240 000 rupees project in 1995 to reduce effluent waste by 140 m^3/day in the plant.

Environmental profile

The company has prioritized protection of the environment and in overall improvement of the environment so that the world is a safer place for the future generation.

The SBL has a well-defined environmental policy, which includes adoption of ecofriendly practices, including use of recycled material, introduction of ecofriendly products, and continual improvement of the environmental management system. The unit is ISO 14001 compliant.

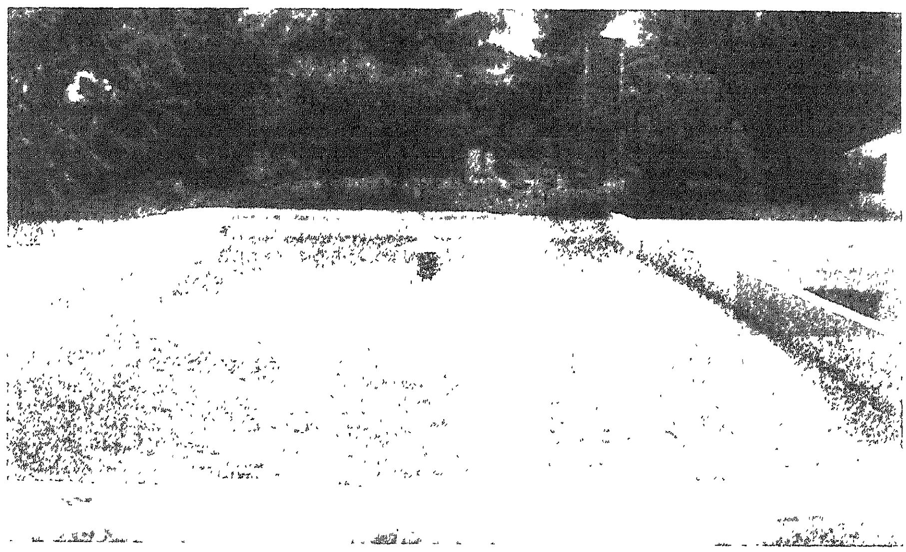
The company has undertaken a number of environmental initiatives, such as elimination of asbestos and increase of asbestos-free production, elimination of hazardous materials in production, reduction in fuel consumption, reduction in power costs, reduction in air-borne asbestos dust in the working zone, recycling of wastes, and introduction of process changes to reduce wastes.



The dust from bag filters is collected in polyethylene bags

All machines that release dust are connected to a centralized 'dust control system' that includes pre-collectors, bag filters, a pulse jet system, and a landfill method. Through the process, 30% of the waste generated is recycled. Flue gas emissions are connected to stacks with suitable height prescribed by the pollution control board to satisfy the ambient air quality standards.

No process waste water is generated by the SBL. An activated sludge extended aeration process treats domestic sewage waste water. The treated water is used for developing a green belt. The company has planted over 15 000 trees inside the company complex.



Treated water is used for green belt development

The SBL is also maximizing re-usage of solid waste and the remaining waste, which contains asbestos, is disposed of in a landfill.

The company carries out regular energy conservation audits and has implemented an energy conservation programme, which has helped reduce power cost from 10.75% to 9.6% in the last two years.

Case study

The company is moving towards environment-friendly non-asbestos products. At present, 45% of the SBL's products are asbestos-free and the company plans to take this up to 65% in the next three years. Simultaneously, re-usage of solid waste is expected to move from 30% to 40%. The SBL has ambitious plans to plant 10 000 trees in the next five years using recycled water—taking the count to 25 000.

The SBL undertook a project for conversion of slab process (multi-piece product) to the DFM (direct fill-moulding) (individual product) process. This project helped to minimize solid waste generation and processing time, which led to energy savings that further led to reduced product cost.

In the previously used slab process (multi-piece product), various raw materials are weighed in a definite proportion and mixed using machines. The mix is weighed and formed into a slab by pre-forming operations and the product undergoes pre-curing. After pre-curing, the pre-forms are cured in cavities and further curing is done in ovens. The cured slabs are cut and drilled as per customer requirement.

The company felt a need to modify the process, as the process loss was high and a number of non-value-added operations were involved. It thus proposed the adoption of the DFM method where after the raw materials are weighed and mixed, the mixes are again weighed and directly cured in cavities. Pre-forming and pre-curing operations are eliminated. The cured products are post-cured in ovens and finished as per customer requirements.

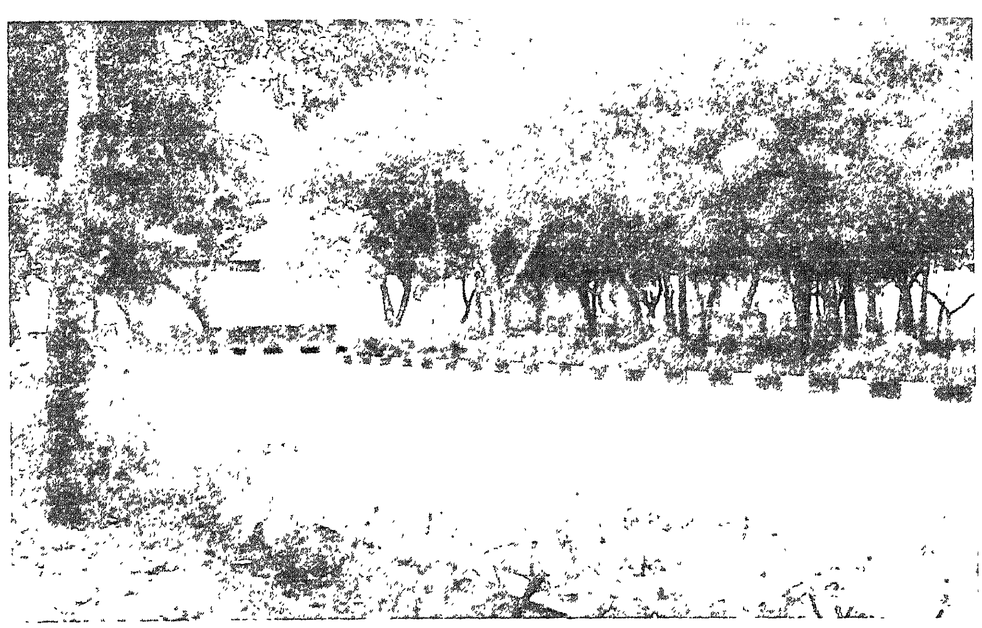
The DFM process was introduced in 1996 and today, 70% of the production is done through this process. The company intends to convert the rest to this process also, over a period of time. The key driver for the adoption of this programme was the desire of the management to employ a higher yielding, flexible technology to reduce generation of hazardous wastes.

Through a judicious mix of reduction in costs and increase in revenues by change in the process from a slab process to the DFM process, the company has tried to reduce the payback period.

The measurable benefits for the project have been in the following forms.

- *Improved yields* Yields have improved by 20% due to reduction in operator fatigue and minimization of process wastes.
- *Reduction of hazardous wastes* Changes made in formulations to suit the DFM process have eliminated hazardous materials like dimethylene chloride and toluene—about 10% of the total waste.
- *Reduced energy requirement* Elimination of pre-curing and pre-forming has reduced power consumption by two per cent.
- *Reduction in lead time* The production lead-time is now down to one day from three days previously.

After the introduction of the DFM process, the inflexible high-volume production has been replaced by flexible low-volume production. Moreover, a significant environmental benefit for the region as a whole has been the reduction of asbestos-based products, which the company is planning to reduce further.



Environmental initiatives taken by the company: more than 15 000 trees planted in the company complex

Case study at a glance

The environmental efforts undertaken by the SBL (Sundaram Brake Linings) Ltd show that the success of any environmental initiative lies in a holistic approach of the management towards environmental issues. The approach and attitude exhibited by the SBL management permeated the hierarchical levels in the organization. By changing the process used to manufacture brake linings from slab to the DFM, the company has not only reduced waste but has also increased yields, flexibility, and efficiency. The efforts have yielded many measurable environmental benefits.

- Improved yields, which have gone up from 60% to 80% due to reduction in operator fatigue and minimization of process wastes
- Minimized hazardous wastes by at least 10% due to a change in formulations to suit the DFM process; hazardous materials like dimethylene chloride and toluene have been eliminated.
- Reduced energy requirements by two per cent by eliminating pre-curing and pre-forming.
- The company can now produce more number of asbestos-free products. It has thus become more environment-friendly and has less variations in product quality.
- Reduced production lead time by two days

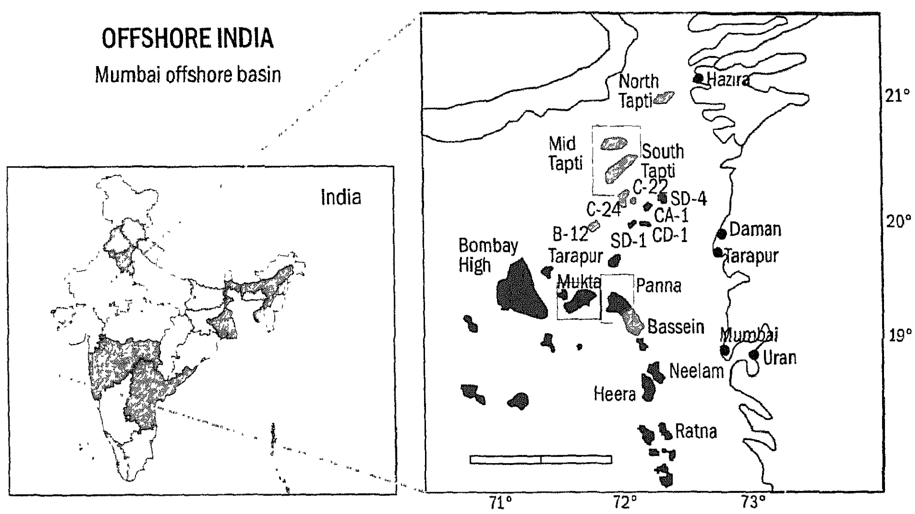
ENVIRONMENTAL MANAGEMENT SYSTEM

CASE STUDY

24 BG Exploration and Production India Ltd

Background

BG Exploration and Production India Ltd (formerly Enron Oil and Gas India Ltd), with its JV (joint venture) partners ONGC (Oil and Natural Gas Corporation) and RIL (Reliance Industries Ltd), operates two offshore oil fields—Panna/Mukta and Tapti. The JV has installed a new offshore processing platform and three new satellite platforms and has drilled 46 new wells in 6 satellite platforms in the Panna/Mukta field. It produces 30 000 bbl/day (barrels per day) of oil and 2.5 MCMD (million cubic metres per day) of natural gas. The Tapti field produces 200 MCF of natural gas per day.



Locations of the offshore oil and gas fields in Arabian Sea, western India operated by the JV

Environmental profile

Prior to the commencement of the JV, a detailed environmental impact study was conducted and an environmental management plan was prepared. Most requirements for field development were implemented as part of the design process at the engineering stage. During the implementation stage, many environmental initiatives were implemented through continuous engineering upgradation, operation improvements, and procedural adjustments. The JV made an effort to address major environmental concerns like oil spills or oil content in produced water as well as the safety of the employees. It has gone beyond the compliance of statutory requirements during the past five-year review period.

The marine environment around the offshore installation in Panna/Mukta is monitored twice a year (pre- and post-monsoon), and the last ten surveys indicate that there has been no evidence of pollution in the environment.

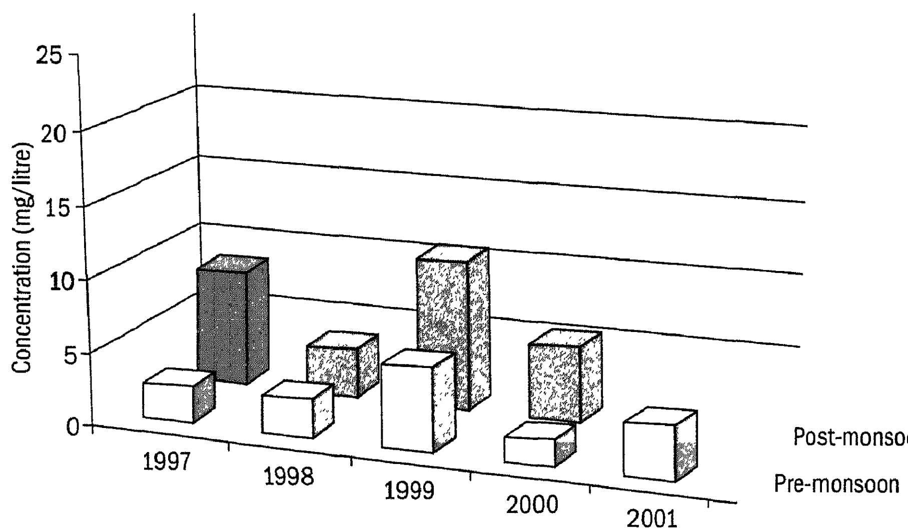
Case study

The JV has striven to address key environmental issues and go beyond statutory compliance during the past five-year review period. The key environmental issues addressed are discussed here.

Oil content in produced water

The issue of oil content in produced water was addressed at the design stage itself. A hydrocyclone and a skimmer have been provided for removal of residual oil in produced water. The treated overboard water quality is maintained within 40 PPM (parts per million). Various experiments have been carried out for improving the water quality. These included varying dosages of emulsifiers, injecting them at different points in the process streams and closely monitoring the overboard water quality. Once the fluid flow stablized and the demulsifier's injection rate optimized, the produced water quality improved significantly at less than 30 PPM. The increased temperatures in the well fluids also helped in achieving improved oil-water separation.

The JV is planning on installing an online oil content analyser, which will provide a continuous status for quickly taking effective measures in the event of deterioration in the overboard water quality.



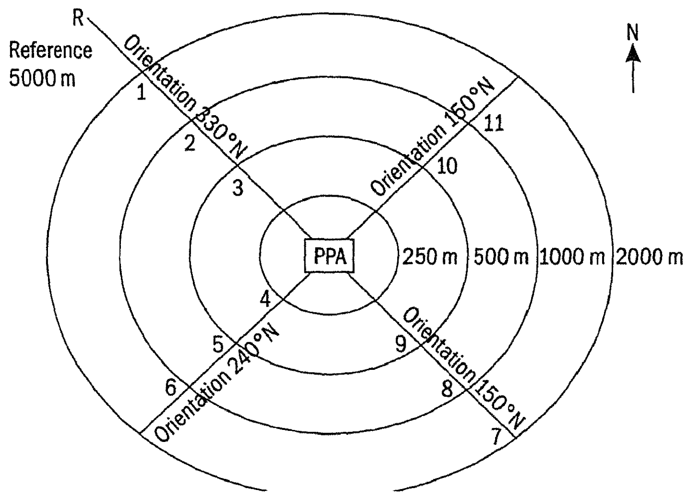
Graph showing average petroleum hydrocarbon content in sea water in the vicinity of Panna processing platform

Flaring and venting

The JV has laid a new gas export pipeline to eliminate flaring in the Panna field, thus saving 0.85 MCMD of gas. It has installed flowmeters to ascertain the quantity of gas being flared. An engineering study, commissioned to check the feasibility of eliminating flaring, indicated that zero flare was not possible as the gas contained hydrogen sulphide. However, 42.5 TCMD (thousand cubic metres per day) of gas flowing to the flare has been recovered by repiping the condensate line to the oil treater inlet.

A new liquid recovery system has been planned to reduce flaring further. Intermediate coolers have been installed to reduce temperature in the gas stream so as to knock out the condensate into the oil stream. The flares from the dry oil tank have been reduced by cooling the oil stream with sea water.

The compressor recycle station, which was implemented for operational reasons, has also helped in reducing flaring, as the compressor cycle can be started up with even 0.57 MCMD flow as compared to the earlier requirement of 1.98 MCMD. This has helped in avoiding the initial flaring otherwise required during each start-up.



The environmental monitoring locations around the offshore installation in Panna field

Drilling discharges

The cuttings from the drilling process are being discharged into the sea as allowed by regulators. The company uses the latest solid control facilities to maximize the reuse of mud and chemicals and reduce its discharge along with the drill cuttings.

In areas where wellbore difficulties were faced, the water-based drilling mud system was replaced by an oil-based mud system with a cuttings re-injection option for disposal of drill cuttings. A formation 1000 metres below the sea-bed was identified as suitable to hold the cuttings slurry. This proposal for zero disposal of drill cuttings to marine water has been agreed to by the regulators. Fifteen Panna wells used this method; this halved the disposal of cuttings and chemicals.

Presently, the JV is working with other operators and the regulatory authorities to revise the guidelines related to drilling to make them practical, environmentally acceptable, and economically feasible.

Waste management

The JV has developed a waste management plan to minimize, recycle, and dispose of waste. Paper, plastic, and food waste is segregated at the offshore installations. The food waste is disposed of at sea. The plastic and paper waste is taken to the shore. Used oil and chemicals are also brought to the shore for selling to vendors for recycling. Special tote tanks are used wherever possible for transportation of various chemicals and fuels for their safe handling.

The JV uses an innovative bioremedial measure for disposal of 3000 drums of oily sludge. A solvent is used to break down the complex hydrocarbon to smaller fractions. This is mixed with soil in an area of about 100 m^2. The area is watered on a regular basis to enable the micro-organisms to eat the waste oil. In about two months time, the oil content is cleared off and the area is found suitable for plantation.

Oil spill prevention and response

The JV has identified all points in the pipelines vulnerable to loss in thickness or cracks and inspects them regularly. All potential oil spill locations have been identified and included in the inspection and maintenance programme. At the offshore installation, all possible spill points for vessel engines and equipment have been provided with oil pots to enable any leak to be contained and recycled.

A series of responses have been planned to combat an oil spill. For the initial response, a skid mounted oil spill response system is kept ready to deploy on the standby vessel in the field. The system consists of 100 metres of ocean boom and a 100 tonnes/hour capacity weir skimmer, an oil/water separation tank, a crane for handling the boom reel, skimmer, etc. The crew and key persons in the installations have been trained and equipment deployment exercises are periodically carried out to ensure a prompt response in the event of a spill. The stock of dispersant is available both at the installation as well as in the standby boat. The dispersant is not toxic to marine environment and has been tested on crude oil for its effectiveness.

The JV has acquired an oil spill trajectory model that can predict the movement of oil spill. The model has been validated utilizing available tidal data. The prediction by the model helps in utilizing resources effectively and planning for inception of the spill before it reaches the shore, thus minimizing environmental damage.

The average values of petroleum hydrocarbons, which are the top priority pollutants in the context of offshore oil and gas operations, have been monitored around the Panna/Mukta offshore installation. They are well within the permissible range—no noticeable change in these parameters due to oil and gas operations. The average values ranged up to a maximum of 10 µg/litre. A comparison with the values for the reference locations as well as the results of the various other studies conducted in the Arabian Sea reported mean hydrocarbon values (within a depth of 20 metres) between 7.5 and 23.5 µg/litre.

The top management's commitment and efforts towards building an informed, well-trained, and enlightened workforce aware of its environmental responsibility have helped create standards in this industry. The JV's focus on operational areas that have an impact on the environment and the willingness to adopt newly emerging technologies has resulted in maintaining the surrounding environment without any deterioration.

Case study at a glance

The BG Exploration and Production India Ltd, a subsidiary of BG Group plc, along with its JV (joint venture) partners ONGC and RIL, operates two offshore oil fields, Panna/Mukta and Tapti.

Since the beginning, the JV has laid emphasis on the protection of the people, safety of the employees, and protection of the environment as an integral part of the overall management responsibility. It has in place a health, safety, and environment policy and is a part of the National Oil Spill Disaster Contingency Plan coordinated by the Indian Coast Guard and also a member of the EARL (East Asia Response Ltd), Singapore.

Environmental concerns were addressed in the design and engineering stage of the JV itself. The main concerns addressed by the JV were oil content in produced water, flaring and venting, drilling discharges, waste management and oil spill prevention, and response. The marine environment around the offshore installation in Panna/Mukta is monitored twice a year, and the last ten surveys indicate that there has been no evidence of pollution in the environment.

The company's environmental policy along with its willingness to adopt emerging technologies have resulted in the following environmental benefits.

- The produced water quality has improved significantly at less than 30 PPM.
- The new gas export pipeline has eliminated flaring in the Panna field, thus saving 0.85 MCMD of gas.

- The compressor recycle station has helped in avoiding the initial flaring otherwise required during each start-up.
- The drilling with oil-based mud option for disposal of drill cuttings has helped halve the overall cuttings and chemicals disposal into the marine environment.
- The innovative bioremedial measure for disposal of drums of oily sludge has helped break down complex hydrocarbons and make the land available for reuse.
- The average values of petroleum hydrocarbons, which are the top priority pollutants in the context of offshore oil and gas operations, monitored around the Panna/Mukta offshore installation are well within the oceanographic range and there is no noticeable change in these parameters due to oil and gas operations. The average values ranged up to a maximum of 10 μg/litre. A comparison with the values for the reference locations as well as the results of the various other studies conducted in the Arabian Sea reported mean hydrocarbon values (within a depth of 20 metres) between 7.5 and 23.5 μg/litre.

CASE STUDY

25 Gujarat Ambuja Cements Ltd

Background

The GACL (Gujarat Ambuja Cements Ltd) formed in 1984, owns installed capacity of over 12 million tonnes per annum, employs 2200 people, and sells over 20 billion rupees of cement annually.

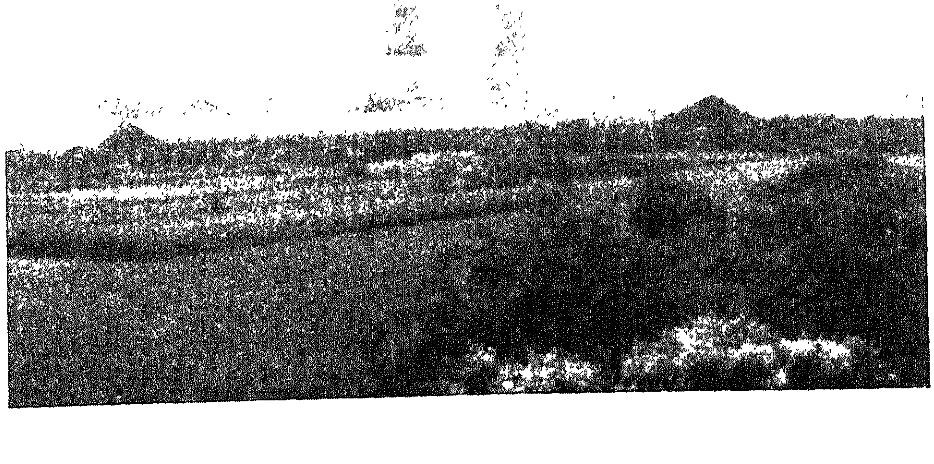
The ACF (Ambuja Cement Foundation), an independent non-profit organization that works in collaboration with local, national, and international development agencies, was set up by the GACL in 1993. The main activities of the ACF are water resource development, check-dam construction, storm water canalization, construction of rainwater harvesting structures, agricultural development, environment conservation, construction of roads, provision of health facilities, construction of overhead water tanks in villages, and protection of natural water resources.

By signing the charter on CoRE (Corporate Roundtable on development of strategies for the Environment), initiated by TERI, the GACL has confirmed its support for the principles outlined in the CoRE sustainability charter and expressed its commitment towards the goal of environmental and economic excellence.

Environmental profile

The GACL has an EMD (environmental management division) at all its units. The EMD regularly monitors and analyses meteorological parameters, ambient air quality, stack emissions, and water; maintains the APCE (air pollution control equipment) and the sewage water reclamation plant with support of the maintenance department; monitors health and safety measures with support of the health department; and strives to make all employees, their families, and the people in the region aware about the environment.

The GACL maintains a horticultural department at its plants to develop a green belt and restore mined land.



'he Gujarat plant

The GACL has been chosen for many prestigious awards for its initiatives in the field of environment; among them are the National Award for Prevention and Control of Pollution conferred by the Ministry of Environment and Forests in 1991 and TERI's highest rating of Gold Eco-Star for class performance on environment, health, and safety.

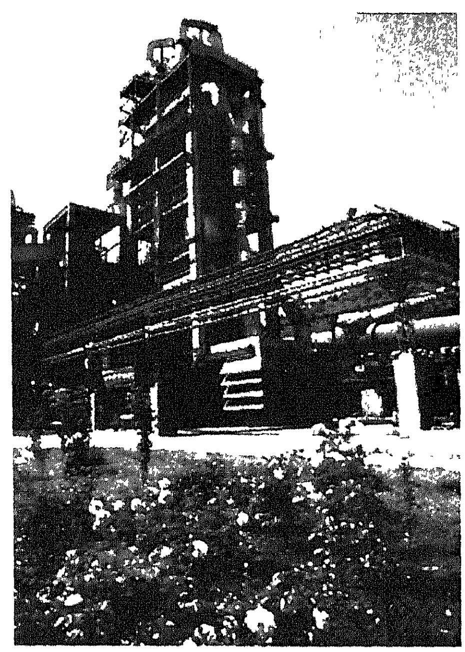
Case study

Air pollution

In the process of cement manufacturing, dust is generated at many stages.

- Mining and crushing of raw material
- Storage and pre-blending of raw material
- Grinding, blending, and homogenization
- Pyro-processing
- Clinker storage and transport
- Cement packing operation
- Conveying of raw material and finished products

A glass bag house has been installed in kiln and raw mill section, which emits the most dust. Electrostatic precipitators have been installed in the cement mill and clinker cooler sections and bag filters at the crusher, cement mill, coal mill, and packing plant to control emission. All the conveying systems are covered. Bag filters have been installed at all material loading, unloading, and handling points to prevent fugitive emission. The Stacker–Reclaimer for limestone has also been covered. Cement and fly ash are stored in closed silos. Clinker is stored in a covered yard. Roads within the plant area are metalled. A mobile van regularly monitors ambient air quality at various stations within a 5-kilometre radius.

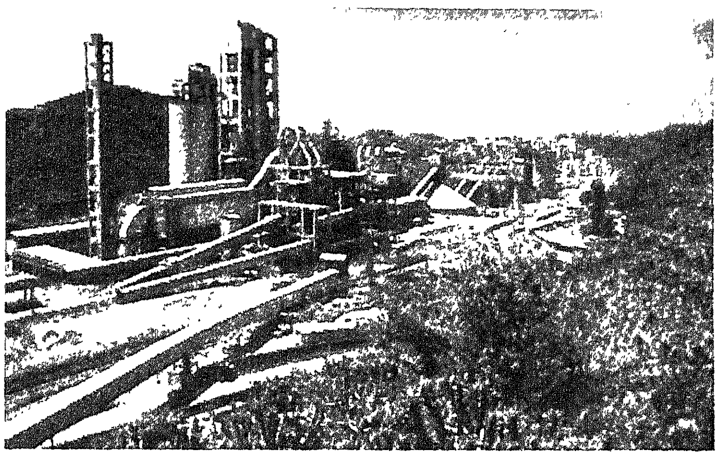


Pre-heater in the unit in Himachal Pradesh showing rose garden adjacent to kiln

Water and soil pollution

Water is used in a cement manufacturing plant only for cooling purpose. There is no industrial effluent; there are only evaporation losses. For the treatment of sewage from the colonies, the SWRPs (sewage water reclamation plants) based on the activated sludge process have been set up at all GACL plants. The treated sewage water is recycled for plant cooling purpose, greenery development, and spray on haul roads in mines. Separate drains have been made at all locations for the canalization of storm water. This helps in rainwater harvesting.

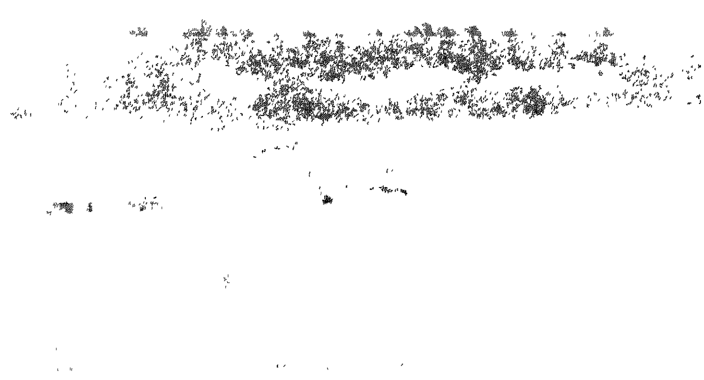
There is no solid waste generation from the plants. All dust collected in the APCE is automatically recycled into the process. Sludge from the SWRP is utilized as manure for horticultural activities and the leaves falling from trees are used for mulching in the gardens and green belt areas.



The unit in Himachal Pradesh showing lush greenery in the vicinity

Environmental management in mines

The GACL owns and operates captive limestone mines both in Gujarat and Himachal Pradesh. For mining of limestone, rock is primarily blasted to separate the material from the earth's surface; thereafter a rock-breaker is used to minimize secondary blasting. But the Gujarat unit is explosive-free, as a surface miner is used there for mining of limestone. This has an in-built water spray arrangement that suppresses dust at source. The GACL has envisaged a phased programme of land restoration of mined-out areas for better land-use. The activities include utilization of land for civil construction, creation of water bodies, reclamation under biodiversity programme, soil management, green belt development, agro-farming, and orchards and pasture land development. It has been observed that birds have been visiting the area especially during November to January. The birds identified are Demoisalla crane, golden plover, and kingfisher.



A surface miner

Bulk transportation

Ambuja Cements is a pioneer in bulk cement transportation. It has set up three bulk cement-handling facilities at Muldwarka and Surat in Gujarat and Panvel-Navi Mumbai in Maharashtra. Cement in bulk is transported through specially designed ships from Muldwarka to Surat and Panvel. There are advantages of bulk marine transport of cement from the environmental angle.

- Reduces consumption of petroleum products for transport per tonne of cement in comparison to road/rail
- Prevents fugitive emission from vehicular movement
- Prevents congestion of over-crowded highways
- Prevents pilferage of cement during transportation, loading, and unloading.

Himachal Pradesh unit

The GACL's Himachal Pradesh unit is located 48 km north-west of Shimla in village Suli of district Solan. The limestone mines are located at an aerial distance of about 2.8 km from the cement plant.

One glass bag house, three electrostatic precipitators, and 54 bag filters have been installed for air-pollution control. Fourteen per cent of the capital cost incurred has been towards environmental management. Domestic waste water is treated in a sewage water reclamation plant and then used for cooling the plant and for greenery development. No hazardous waste is generated either in the process or pollution control facilities. The sludge generated from the sewage treatment plant is used as manure for the green belt.

A rock-breaker is used for mining. This avoids secondary blasting, and results in less fugitive emission and fewer and less intense vibrations. The ripped material is crushed and transported to the plant by a totally covered belt conveyor that is 2.8-km long and passes through three tunnels. Bag filters have been installed at the crusher and all transfer points to control fugitive emissions.

The emissions from the stacks are below 50 mg/Nm^3, which are much below the stipulated standards. The ambient air quality is monitored regularly within a 5-km radius of the plant and the mine.

The unit began planting trees before the construction of the plant. A large part of the area where mining work has been carried out has already been rehabilitated, and the rest will soon be.

The first plant of Ambuja Cements was cited as an example for the Indian cement industry in terms of high production efficiency and excellent environmental management.

Water resource development programme

The main water-related problems of the neighbouring area are groundwater depletion and salinity. Various projects have been undertaken to improve the groundwater table and to control and prevent increase in salinity. To raise the groundwater table, check-dams and percolation-cum-storage tanks have been built and repaired, farm ponds have been built for irrigation support, and approximately 600 wells have been recharged. For drinking water, 25 rooftop rainwater harvesting structures have been built. Water is no longer required as a coolant in the plant, as air coolers have been installed.

Waste minimization

The minimization of waste occurring from the production process not only keeps the plant clean but also helps increase the production efficiency of the plant. The main focus areas for waste minimization are fugitive emission and waste during storage of material.

Energy conservation

The GACL has initiated several measures for energy conservation, which include retrofitting energy-efficient equipment and systems, technology upgradation, process optimization, efficient energy monitoring, and energy audit.

Research and development

Due to the GACL's in-house R&D activities, groundnut husk, an agricultural waste product, is being utilized as a substitute for fuel in the kiln in Gujarat. Another discovery was the utilization of waste fluorspar generated by the Gujarat Mineral Development Board. Fluorspar, when mixed with other materials, reduces the melting point of the mixture, thus reducing fuel

consumption by three per cent. Efforts are on for the utilization of other agricultural wastes like castor oil husk, castor cake, and bagasse as fuel substitutes.

Case study at a glance

- The GACL (Gujarat Ambuja Cement Ltd) goes beyond compliance to look at environmental issues straightforward. Its strategic decisions are focused on sustainability, so much so that right from when its foundation works began in the area, there was focus on natural resource management in addition to social welfare.
- It has adopted environmentally sound technologies and found ways and means to restrict pollutants emitting from its plants. To minimize the problems arising due to generation of dust, glass bag houses along with electrostatic precipitators and bag filters have been installed at appropriate locations in the plants.
- Sewage water reclamation plants are set up in all GACL plants to treat the sewage water, which is then recycled for cooling, green-belt development, and spray on haul roads.
- Surface miners, which suppress dust at source, are used for limestone mining.
- The company has initiated a programme to restore the mined-out lands.
- Facilities for bulk marine transport of cement in certain plants save fuel and prevent fugitive emissions and pilferage of cement during transportation. The bulk cement transportation system can be emulated by others in this industry.

CASE STUDY

26 Mahanadi Coalfields Ltd

Background

The Mahanadi Coalfields Ltd, a subsidiary company of the Coal India Ltd, is one of the largest coal-producing companies in India. The company manages the Talcher and Ib Valley coalfields. It operates in Orissa and is headquartered at Sambalpur, Orissa. It started operations in 1992. The company owns six opencast mines and five underground mines in Ib Valley and eight opencast and three underground mines in Talcher.

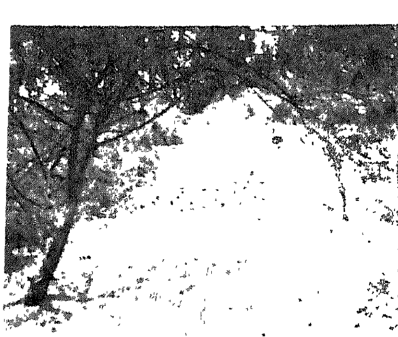
Environmental profile

The Mahanadi Coalfields' environmental policy is focused on sustainable development. Its safety, health, and environment department ensures that its actions conform with its policy.

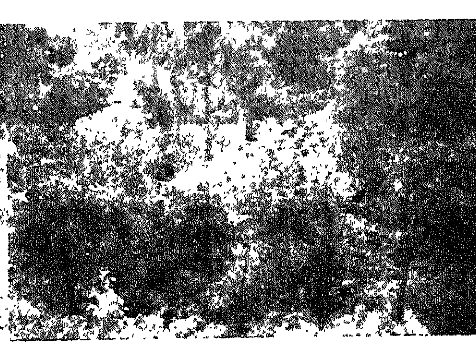
The Mahanadi Coalfields Ltd has developed its environmental policy and has built the infrastructure required for the implementation of its environmental initiatives. The company has taken a number of environmental initiatives in the past. It has received the Indo-German Greentech Environmental Excellence Award for outstanding achievements in the corporate mining sector. Mahanadi Coalfields spends 40–50 million rupees every year on its community development programmes, which includes the construction of roads and bridges, schools and colleges, electrification of villages, and digging of tube wells. There is an allocation fund in each mine for mitigating the environmental impact of mining activities: 9%–13% of the total capital cost, and Rs 6–11/tonne of coal and revenue expenditure. Some of the initiatives undertaken by the company are listed below.

Air initiative

The main pollutants generated during coal mining and transportation are SPM (suspended particulate matter), RPM (respirable particulate matter), CO (carbon monoxide), HC (hydrocarbons), SO_x (oxides of sulphur), and NO_x (oxides of nitrogen). Of these, CO, HC, SO_x, and NO_x are quite low in concentration and are diluted in the atmosphere. For SPM and RPM, the company has taken a number of abatement measures such as rapid loading system; fixed water sprinklers at the point where mining is done as well as on



Check-dam in the gullies at 6 m interval



NEERI-MCL IBA demonstration site



Laying of coir geotextile at OB dump slope



Transportation and haul road are metalled and are sprayed with water regularly to control dust and ash in the atmosphere

roads, railway sidings, and other dust generating sources; use of surface miner; no drilling; no blasting; and reduction of ash in coal by selective mining.

Water initiative

The effluent generated is recycled for in-house consumption. Effluent that is high in TSS (total suspended solids) is treated through chemical dosing and is used for fire fighting, dust suppression, and watering plants. Effluent from the workshop, which is high in TSS and oil and grease, is separated in the oil and grease trap. The emulsified oil and grease is separated by chemical treatment. Domestic sewage is treated in the sewage treatment plant and is then used for watering plantations.

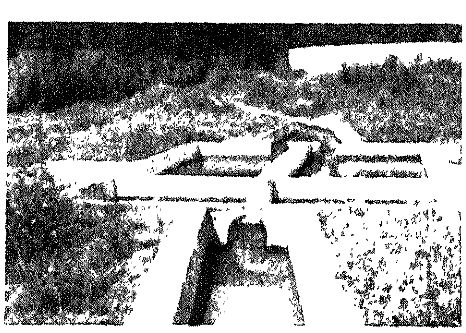
Resource conservation initiatives

The company has undertaken a number of soil conservation initiatives. These include application of coir-geotextile on the steep slopes to arrest soil erosion and improve moisture retention. Contour trenches and bunds, along with check dams and gully plugging, have been constructed for rehabilitation of old, overburdened dumps. Technical reclamation is done properly along with dozing, top-soil layering, mulching, etc. before biological reclamation so as to minimize soil erosion.

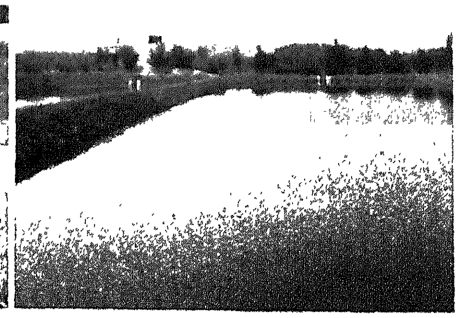
Green initiative

The company undertakes massive afforestation programmes, wherein 0.3 to 0.4 million trees are planted every year. These restoration programmes have focused on reclaiming land, minimizing pollution in air and water, and improving the quality of life of the residents in the plants' vicinity.

The company implemented an environmental and social mitigation project between July 1996 and June 2001. The World Bank and the Exim Bank of Japan funded this 65 million dollar project. It comprised an environmental action plan, a rehabilitation action plan, an indigenous people's development programme, a dust suppression plan and an overburden dump action plan. The project was implemented under the supervision of the World Bank.



Oil and grease trap



Mine discharge treatment plant

Case study

Land reclamation was the first priority for Mahanadi Coalfields Ltd, as the volume of soil (overburden) loosened by mining was much less than the void created (average stripping ratio of 1:1:1), and land fertility was being destroyed. Also, back-filling was begun earlier than usual, external dumping was restricted, a top-soil utilization programme was implemented, coir-geotextiles were used on steep slopes to arrest soil erosion and improve moisture retention capacity. Biotechnological reclamation, using biofertilizers, farm yard manure, soil amendments with fly ash, saplings grown with root tenure technology, was carried out.

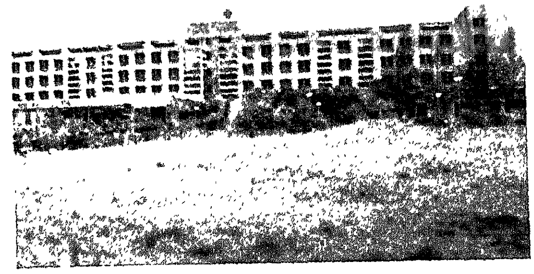
As mentioned earlier, mining and transportation of coal generates CO, HC, SO_x, NO_x, SPM, and RPM. To control SPM and RPM

- transportation roads have been metalled and blacktopped,
- haul roads have been metalled and blacktopped,
- instant shower systems have been installed in the coal transportation roads,
- concurrent shower systems have been installed in the coal-handling plant chute,
- 28- and 35-kilolitre mobile sprinklers are available in each project,
- coal is transported over water wherever possible, and
- green belts are developed around dust-generating sources.

Mining also affects water—it lowers the water table. Big opencast mines consume huge quantities of water, resulting effluents from mines contain high TSS and effluents from the workshop contain both high TSS as well as oil and grease. The total effluent generated is recycled for in-house water consumption, so there is no discharge from the mines to the external environment. The effluent from the mine that has high TSS is treated in the mine discharge treatment plant with chemical dosing arrangement; the treated water is used to water plants, suppress dust, and fight fires in the stocks and in railway sidings.

Effluent from the workshop contains TSS, oil, and grease. An oil and grease trap separates oil and grease from the stream, and chemical treatment separates the emulsified oil and grease. The treated water from the workshop effluent treatment plant is used to wash vehicles. Domestic effluent is treated in the sewage treatment plant and the treated water is used for plantation purposes. Water is harvested in huge voids, raising water level significantly.

The Mahanadi Coalfields Ltd spends up to 50 million rupees annually under its community development programme for constructing roads, bridges, school and college buildings, hospitals and dispensaries, and installing tubewells and handpumps. It regularly organizes free camps for eyecare, family planning, and vaccination. It has planted 7 million trees; many villagers depend on this plantation for fuel, fodder, and income. Community relations have improved significantly, as the successful implementation of the environmental and social mitigation project has resulted in better facilities for


Central hospital at Talcher

medical care and education, in access to power, railways and roadways, and better chances of employment and income.

Case study at a glance

The MCL (Mahanadi Coalfields Ltd) has an environmental policy that focuses on sustainable development, safety, and health. In the past, the company has effectively addressed issues and problems related to air and water pollution, resource conservation, and green belt development. However, land reclamation has been the top priority area for the company, as the overburden soil loosened by mining operations was much less than the void created. Due to this, the land fertility was also being destroyed. To reclaim the land, the company took the following measures.

- Backfilling was begun earlier than usual.
- External dumping was restricted.
- Coir-geotextiles were used on step slopes to arrest soil erosion.
- Roads have been metalled to control suspended particulate matter and respirable particulate matter from transportation.
- Instant shower systems have been installed in the coal transportation roads.

CASE STUDY

27 Praxair India Private Ltd

Background

The PIL (Praxair India Ltd), a subsidiary of the US-based Praxair Inc., was formed in 1996 with its headquarters in Bangalore. With an investment of 250 million dollars, Praxair is now the premier player in the Indian gas market with consolidated sales of about 100 million dollars. The PIL has 35 operating locations in India. Involved in the manufacturing of atmospheric and specialty gases (liquid oxygen, liquid nitrogen, gaseous nitrogen, and gaseous hydrogen), it is also a technology leader and sells its patented process improvement technologies to various customers spread across a number of industries. The Praxair Carbon Dioxide Private Ltd, another concern of Praxair Inc., is the largest supplier of CO_2 (carbon dioxide) to the food and beverages industry as well as the engineering industry in India.

Led by a group of professionals with many years of experience in the oil and gas industry, the PIL has brought in new quality, safety, and environment standards in manufacturing, distribution, and customer applications of industrial gases in India.

The PIL has always been environmentally conscious and responsible, and has implemented several environment management programmes. The air separation unit of PIL at Sriperumbudur, Tamil Nadu, makes a good example of sustained efforts towards saving energy and the environment.

Environmental profile

The PIL's environmental policy, which was adopted in 2001, is along the lines of the safety and environmental policy adopted by Praxair worldwide. The company's manufacturing facility at Sriperumbudur is ISO 14001 certified. The company regularly practices rainwater harvesting at the facility. Energy and water balancing is carried out regularly to conserve water and energy. The plant has been awarded the 'M' (Meets) rating by Praxair's Global Safety and Environmental Services. Some of the initiatives taken by the company as regards energy and the environment are highlighted here.

- The PIL has taken utmost care to minimize pollutants (suspended particulate matter, oxides of nitrogen, oxides of sulphur, etc.) released into the atmosphere.
- The PIL follows the concept of zero effluent discharge outside the plant. No water pollutant is released from the facility.
- Waste oil, a hazardous waste produced as a result of sludge from HFO (heavy fuel oil), is pumped through a safe process to a vendor having authorization from the pollution control board for incineration.
- The company has designed a rainwater harvesting system in-house that has enabled the company to have a readily-available water resource. This pure rainwater also improves the COC (cycles of concentration) resulting in reduction of the usage of water treatment chemicals.
- The company has constructed a health centre in a nearby village and has provided educational aids to the village school.

- The company's team has also started a plantation programme where the villagers have also participated. This programme has been designed not only to upgrade the environment but also provide self-employment opportunities in floriculture, fruit selling, and vermiculture.

Case study

Major raw materials at the PIL's facility at Sriperumbudur are power from the electricity board and from the captive power plant run on HFO, water, and chemicals used for water treatment. While the company had already undertaken many water conservation and water treatment initiatives, it also felt the need to undertake action for reduction in electric power consumption. The idea was to have a three-fold result of conservation of energy, conservation of natural resources (HFO, in this case), and prevention of pollution as was a result of using HFO.

The company further reduced its power consumption through the implementation of the MPC (model predictive control) system—a technology, which has never been used by any other air separation plant in India and was facilitated by the Praxair Technology Centre, USA.

The MPC system uses linear dynamic models to predict the open loop behaviour of the controlled variables such as pipeline purity and power. It predicts violation of constraints and takes corrective action based on prediction, which is constantly updated with measured information from the process. The MPC system develops an optimum control solution for a steady-state operation by maximizing production while minimizing power consumption. It also sets right the dynamics of performance where control variable errors and manipulated variable movements are minimized. The basic premise is to run the plant in the best operating region, where the plant can run with minimum airflow (minimum power), minimum distillation column pressure, and with the best oxygen recovery while satisfying all standards of product purity, surge, motor power, and other requirements.

The MPC system calculates the best operating conditions during each two-minute cycle. It tries to satisfy all controlled variable limits, thereby setting optimization goals active. If the controlled variables go out of limit, the MPC system adjusts the manipulated variables to bring them back to their limits, by temporarily suspending the optimizing action.

The specific energy consumption for producing the atmospheric gases at the Sriperumbudur facility is lower than the designed consumption of other facilities of the same capacity. This has set new standards and targets for other facilities to achieve these levels of energy savings. The revenue-generating capacity of the initiative lies in its adaptability as a potential model for energy-intensive process industries.

The advent of MPC has also helped reduce pollution in the plant. Since the only pollution from the plant is in the form of stack emission from the captive plant, any saving in the consumption of electrical energy would directly reduce air pollution. The initiative has also reduced generation of hazardous waste, as lesser use of HFO generates lesser sludge.

The evolution of this system was done with the help of experts, then the system was tested for effectiveness, and the plant was optimized for optimum production with minimum power consumption and optimum product purity. The model was implemented in February 2001 and there is a reduction in specific power consumption in the plant by 18%. The MPC system is the latest technological innovation in the field of process industry and Praxair Inc. is planning to implement the model in all its plants to effect large-scale energy conservation.

Case study at a glance

The Praxair India Ltd has demonstrated leadership in environmental excellence by incorporating the new MPC technology to reduce energy consumption in an energy-intensive industry, thereby reducing the resultant pollution while conserving resources. The company has a clearly defined environmental policy along the lines of Praxair, USA.

The MPC system uses linear models to predict the open loop behaviour of the controlled variables. It predicts violation of constraints and takes corrective action based on prediction, which is constantly updated with measured information from the process. The MPC system calculates the best operating conditions during each two-minute cycle. It controlls the variable parametres, thereby optimizing the plant performance. With the MPC system, optimum operation conditions were achieved, which led to reduced power consumption and consistent product quality.

Some of the environmental benefits of the project are listed below.

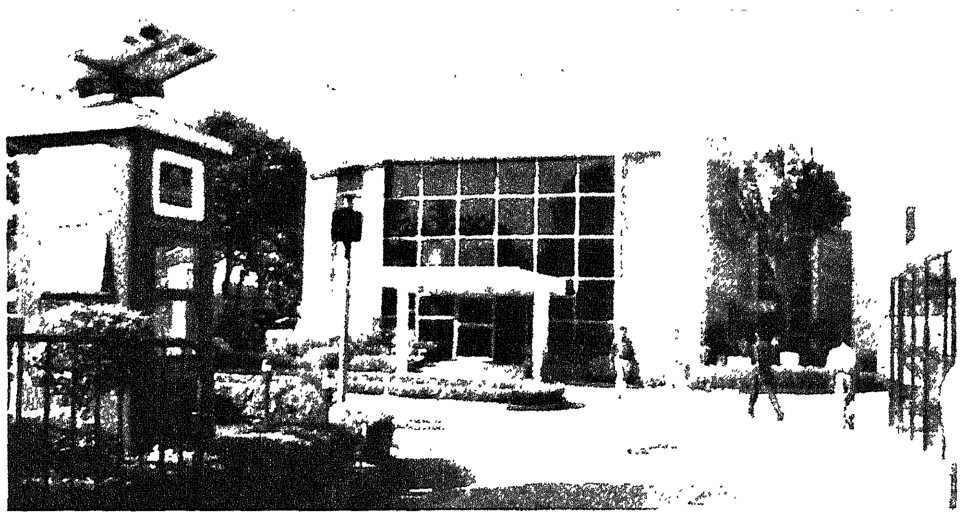
- Due to the implementation of this unique technology, there was an 18% reduction in specific power consumption.
- Reduction in energy consumption has led to reduction in fuel consumption, thereby conserving resources.
- Air pollution has substantively reduced as a result of the reduction in fuel consumption.
- Generation of hazardous waste has come down, as there is lesser use of heavy fuel oil in the plant now.

CASE STUDY

28 Tata BP Solar India Ltd

Background

The TBPS (Tata BP Solar) India Ltd is a joint venture between the Tatas and BP Solar International LLC. It is involved in the design, development, manufacture, marketing, installation, and servicing of photovoltaic modules, systems, solar thermal systems, system accessories, and solar photovoltaic cells. The company's works are located at Electronic City, Bangalore. The company undertook the implementation of a health, safety, and environment system, as a continuous measure to reduce the impact of its operations on the environment.



Tata BP Solar India Ltd at Bangalore

Environmental profile

The TBPS believes in the dictum 'No accidents, no harm to people, and no damage to environment'. It got ISO 14001 certification in 2000. The company abides by all legal and other regulations relevant to its activities, products and services, and complies with all relevant environmental standards. Its emergency management plans cover all possible environmental risks and hazards arising from its activities. The environmental initiatives undertaken by the company include the following.

- To reduce air emissions, solid waste, and liquid discharges
- To conserve energy
- To promote the use of solar energy
- To produce safe and easy-to-use products.

Case study

The company has continuously tried to upgrade its already implemented HSE (health, safety, and environment) system so as to ensure better compliance and productivity. It has tackled the various aspects relating to environmental pollution with a great degree of responsibility and innovation.

Reducing air pollution The air pollutants from the TBPS's manufacturing facility are the following.

- SPM (suspended particulate matter)
- RPM (respirable particulate matter)
- SO_x (oxides of sulphur)
- NO_x (oxides of nitrogen)
- Acid mists
- Lead emissions from soldering stations
- Exhaust from paint booth.

In order to minimize these, the company has provided all the soldering booths with fume extraction systems, which precipitate the lead particles from the air. The SPM, SO_x, and NO_x, generated from the diesel sets, are provided an outlet through the chimneys as per the guidelines of the local regulatory authorities—the Karnataka State Pollution Control Board. The acid mists and exhaust from the paint booth, which are generated from wet chemistry process and paint shop, are neutralized by the scrubber units and chimneys. The new method of cutting rock wool has completely eliminated exposure of dust particles into ambient air.

Reducing water pollution The main water pollutants from the work site are hydrofluoric acid effluent, effluent containing sodium hydroxide, rinse water from water treatment plant, and paint booth scrubber effluent. The effluent generated from the manufacturing process is collected separately in storage tanks and treated at a common effluent treatment facility.

Containing hazardous waste generation The plant generates plastic chemical containers which are neutralized, labelled, and sold to recycling units. The waste out of the printer cartridges is exchanged with an ecofriendly recycling unit, Holland-based Letscorp International.

Change in welding technology The company has used a new innovative technique – ultrasound welding – in the solar water heating manufacturing facility. This has reduced the emissions in the form of SPM and lead content significantly. The introduction of the new welding machine significantly reduced emissions in a stage-by-stage manner.

Process modification Advances in the photovoltaic cell production process have resulted in elimination of use of such chemicals as hydrochloric acid and ammonia, contributing to environment protection. The company evaluates the health, safety, and environment hazards associated with its products/systems and assesses the consequential risks from supply through to disposal. Advice is given to customers for safe handling of products/systems. Management systems are established to collect and review any reported adverse effects and the company responds to requests for emergency HSE information.

The challenges to the programme implementation were overcome through the company's commitment to define achievable targets for continual improvement in the health-, safety-, and environment-related performance of the company and through the monitoring of the process of achievements.

Some of the quantifiable environmental benefits of the project are as follows.

- There has been tremendous reduction of CO_2 (carbon dioxide) emissions as derived from the sale of solar water heating systems.

- The company estimated that in the year 1999, 83 516 tonnes of CO_2 and in 2001, 117 412 tonnes of CO_2 emissions were reduced due to the sale of solar water heating systems.
- The company has targeted to contain CO_2 emissions to 0.1 kg/watt of production by 2002 from the current 0.017 kg/watt (2001). This represents 28% of production in 2001.

Case study at a glance

Initiatives for reducing air pollution

In order to tackle the air pollutants from the operations, the company has provided all the soldering booths with fume extraction systems, which precipitate the lead particles from the air. The new method of cutting rock wool has completely eliminated emission of dust particles into ambient air.

Initiatives for reducing water pollution

The main water pollutants from the work site are hydrofluoric acid effluent, sodium hydroxide containing effluent, rinse water from water treatment plant, and paint booth scrubber effluent. The effluent generated from the manufacturing process is collected separately in storage tanks and treated at a common effluent treatment facility.

Initiatives for reducing hazardous waste generation

The plant generates plastic chemical containers which are neutralized, labelled, and sold to recycling units. The waste out of the printer cartridges is exchanged with an ecofriendly recycling unit, Letscorp International.

Resource conservation initiative

The company has used a new innovative technique – ultrasound welding – in the solar water heating system manufacturing facility, which has eliminated the brazing operations, thus reducing emission of suspended particulate matter and lead significantly.

Advances in the photovoltaic cell production process have resulted in the elimination of usage of environment-polluting chemicals like hydrochloric acid and ammonia.

CASE STUDY

29 The Tata Iron & Steel Company Ltd

Background

TISCO (the Tata Iron and Steel Company) Ltd, part of the Tata Group, is the largest private sector steel manufacturer in India. The company's operations are spread all over India. It has its steel manufacturing unit at Jamshedpur and other manufacturing and mining activities are spread over 8 locations in the states of Jharkhand and Orissa. The company implemented an environmental management system at its Jamshedpur unit.

Environmental profile

TISCO's environmental policy is focused on compliance with environmental laws, conservation of natural resources and energy, minimization of process wastes, recycling, phasing out of pollution-prone processes, development and rehabilitation of waste dumps, and promotion of an environmentally-aware workforce.

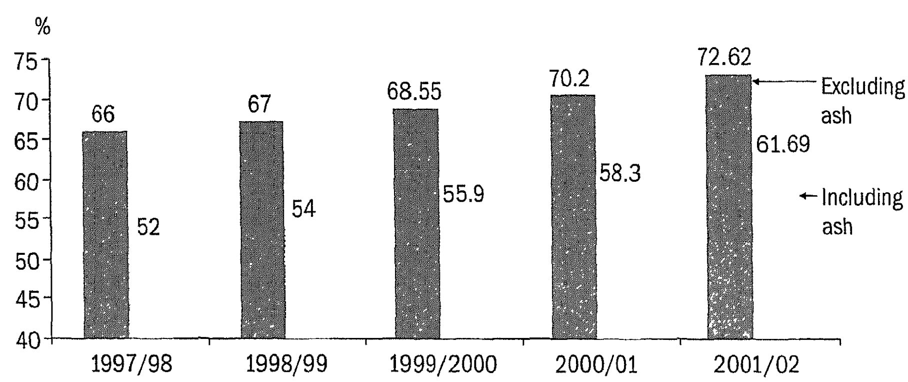
TISCO has always been environmentally active. It was adjudged one of the top ten green companies in India by a TERI-*Business Today* survey (2001). Its growth shop and cold rolling mill are ISO 14001 compliant. It is the first Indian company to have produced a corporate sustainability report (2000/01) as per the Global Reporting Initiative guidelines.

The company has made an investment of 2810 million rupees in 2001/02 for modernization and several state-of-the-art pollution control systems so as to prevent and control pollution. The operating cost on environmental protection has gone up from 252 million rupees in 1997/98 to 650 million rupees in 2001/02. Some of the environmental initiatives undertaken by the company are as follows.

- TISCO reduced consumption of raw material by 10% in 2000/01 due to state-of-the-art technologies, improved operating practices, and recycling/reuse of waste generated.
- For the last three years, the company has been implementing energy-saving measures such as improvements in plant operation, phasing out of higher energy-intensive processes, recovery of waste heat, and optimum utilization of by-product fuels.
- The company has phased out a number of pollution-prone processes. A part of the captive power plant boilers are run on by-product gases. Reduction in energy consumption has had a favourable impact on greenhouse gas emissions from the plant.
- TISCO's stress on water re-circulation in all processes has led to reduction in specific water consumption. Close monitoring of water losses, recycling of ash quenching water from powerhouses, and recycling of waste water from various drains has resulted in a 10% reduction in water consumption over the last year. Waste water from processes is treated with the best available physico-chemical methods and is being recycled in the process. Waste water from the plant is treated biologically, where organic pollutants are oxidized and decomposed by micro-organisms. The consumption of water and discharge of waste water are far below the legal norms.

- Most of the waste generated from the steel works, including blast furnace slag, sludges from gas cleaning plants, dust collected from pollution control equipment, and mill scale are recycled and reused. Approximately 27% of the process wastes during the year 2001/02 was used for filling low-lying areas and peripheral road construction around Jamshedpur.

The company has a well-defined method for disposal of hazardous wastes. The waste is segregated and is stored in colour-coded bins. Oil and grease soaked jute is charged into the steam generating boiler. Tar sludge and wash oil sludge are mixed with coal and the BOD (biological oxygen demand) plant sludge is mixed with coal and supplied as feed to coke oven battery for coke preparation.



Increase in utilization of waste: 1997/98 to 2001/02

Green initiative

As part of its project – the Green Millennium Countdown – the company planted 1000 trees in 100 days. Till December 2000, the company had planted 1.5 million trees. The company has also adopted a concept called 'greening supply chain', wherein it encourages suppliers to seek ISO 14001 certification.

Case study

TISCO's attempt to implement an EMS (environmental management system) as per ISO 14001 started in 1997. The implementation of the EMS reflected TISCO's commitment to continuous improvement in conservation (energy, water, and raw material), management of solid waste, reduction in pollution levels, increased awareness, training and competency of the workforce, and a general commitment to fulfilling the expectations of the stakeholders and the community.

The company set up a core group and appointed a consultant. The system documentation was done and released to all departments for implementation by 1998. However, the audit observation at the department and shop level showed that the deployment of the system was very poor. The system was then scrapped and the company undertook the designing of a world-class EMS.

It decided to learn best practices in EMS design and implementation from Hoogoven Steel, The Netherlands. In 1999, a three-member team was formed to study the benchmarking, redesigning, and implementation of the system. The study recommended that the company make a panel of adequate numbers of qualified and trained internal EMS auditors and modify the

EMS organization structure to integrate it with the existing quality system.

In July 1999, the learnings were implemented and a new system was established. An aggressive system and site audit was adopted at the time of implementation. Several waste management procedures were also developed and implemented for the common steel plant wastes and hazardous wastes. Finally in May 2000, the plant received the ISO 14001 certification.

The company undertook a number of initiatives under the EMS. It replaced the old pollution-prone units. Bessemer converters and open-hearth furnaces were closed down and the conservation-conscious route of steel making was adopted with facilities of fugitive emission control as well as gas recovery facilities. The old top batteries were changed and new stamp charged technology of coke making was introduced with facilities of charge gas cleaning. The old rotary kilns were replaced by regenerative type shaft kilns. Energy consumption was reduced and resource conservation was increased through process modifications, improving recovery of by-product gases, improving usage efficiency through state-of-the-art combustion technology, instrumentation and automation, and intensive monitoring and control.

The challenges to the programme implementation were overcome through a joint effort of a team comprising workers, officers, and top management. The resourcefulness of the people as a team and the support of the top management led to the successful designing and implementation of the EMS.

The key motivator to the programme adoption was the management's keen desire to address all its five strategic goals in an environmentally friendly manner. It linked all the strategic goals with the EMS. Wealth creation was linked through resource conservation and cost reduction. The goal of creation of a culture of continuous learning and change was linked through a better work environment, values, and ethical norms in the Tata code of conduct, and awareness as well as involvement of all employees through a 100% training in EMS. The company's goal of achieving world-class status in services and products was linked to the EMS through the emergency preparedness and response systems and customer satisfaction.

The revenue generating potential of the model is evident from the replication of the EMS design (main unit) in the other units. Many other organizations have benchmarked their EMS with TISCO's EMS. The company freely shares the improvements carried out at TISCO with other steel plants through the National Task Force.

Case study at a glance

- TISCO (the Tata Iron and Steel Company) Ltd has implemented energy saving measures and employed technology to prevent and control pollution.
- The company invested 2810 million rupees for modernization and to prevent pollution. It phased out a number of pollution-prone processes in 2001/02.
- TISCO's stress on water re-circulation in all processes has led to reduction in water consumption.
- The company established an EMS (environmental management system) in 1998 but deployment of the system was very poor. The system was scrapped.
- In 1998 TISCO decided to design a world-class EMS.
- In 1999 a three-member team was formed to study the benchmarking, redisigning, and implementation of the new system.
- In July 1999, the learnings were implemented and a new system was established.
- In May 2000 TISCO became India's first ISO 14001 certified steel plant.

Land Reclamation and Environmental Entrepreneurship

CASE STUDY

30 Biodiversity Conservation (India) Ltd

Background

The BCIL (Biodiversity Conservation [India] Ltd) is a not-for-profit company consisting of a set of professionals drawn from mainstream developmental work, construction, civil engineering, and architecture. It was set up to provide alternative technologies and solutions for urban communities. The company is headquartered in Bangalore. It undertook a campus-based project, Trans Indus, to demonstrate the practical applications of sustainable systems that can go a long way in utilizing resources effectively.

Environmental profile

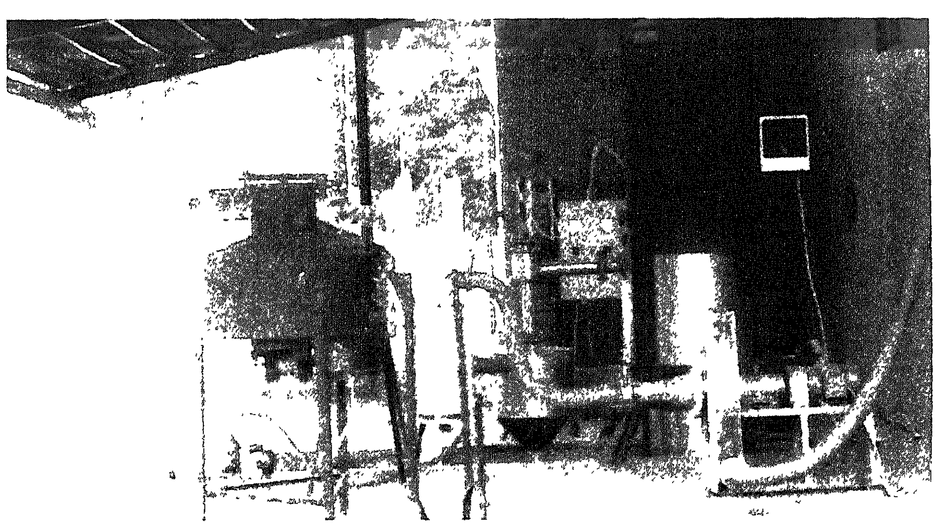
The BCIL believes in devising systems and delivering technologies that are sustainable, based on local skills, respect traditions and values of different cultures, and which are feasible in terms of costs and urban realities. The company is dedicated to creation of alternative technologies and systems that offer solutions for urban living while remaining within the folds of mainstream enterprise.

The company undertook its first alternative solutions and technologies project at Bangalore. The rationale behind choosing the city was that in 1994, like Pune and Bhopal, Bangalore also fell in the category of a town that was growing but was not really a metropolitan one. It could be said that it had the spirit of a small town. The city showed the potential for growth combined with the charm of a small town.

Case study

The platform on which Trans Indus was established was the creation of infrastructure that will reduce, if not eliminate, dependence on state infrastructure for power and water. The other infrastructural resource that Trans Indus was committed to providing was global connectivity in a manner that will help residents to work out of home without having to suffer the daily ennui of commuting to work places

Central to the creation of Trans Indus were values of greater efficiency in the use of energy and taking on the traditional skills and competencies for



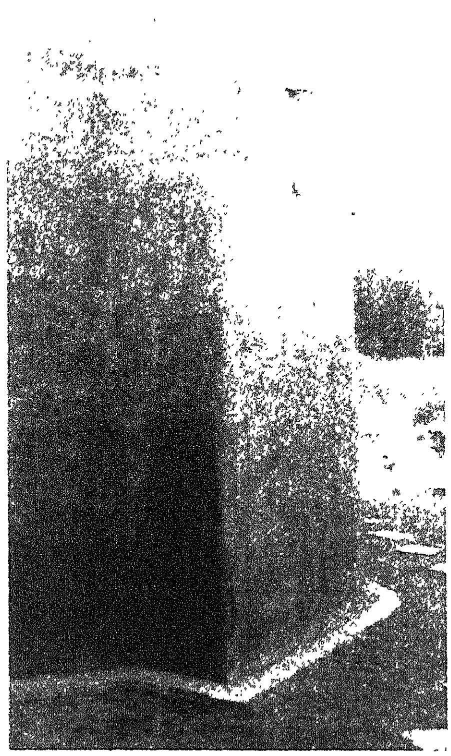
The biomass gasifier installed at Trans Indus saves as much as Rs 1.40 per unit of consumption at optimum load. The use of captive power not only brings uninterrupted supply but also sharply enhances the quality of power supplied to homes. Our captive generation capacity is backed up by a bulk load sanction from the electricity board grid, which is utilized in the non-peak load hours of the day.

delivering sustainable solutions. The 140-million-rupee project took seven years to complete and demanded considerable ingenuity, innovation, perseverance, and dedication to deliver on cost, aesthetics, function, and ease of execution.

The main initiatives undertaken in the programme are as follows.

Building sensitivities

For building homes and other structures at the campus, the company blended traditional technologies with contemporary engineering practices for construction of walls, roofs, woodwork, joinery, and floors. It incorporated systems that treated black (sewage) and grey (sullage) water. It also provided electrical energy, solar energy, state-of-the-art fibre optic cabling for global connectivity, and potable water to each home.



These timeless adobe walls are an example of our application of a traditional technology in contemporary engineering contexts. The wattle-and-daub method of construction of mud walls is used to involve wattle stalks for forming the grid on which the earth was daubed. Instead, we use a mesh of reused plastic strands to provide the framework and base for the mud plaster. This system qualifies as an excellent example of recycling an otherwise useless and harmful material. It also represents a good example of a traditional technology adapted to use a more commonly available non-biomass-based substitute.

Trans Indus has 28 homes, which have been handed over to people and are occupied today. The complex will ultimately have 42 homes over a campus of 20 hectares. It is estimated that the total plinth area of construction will not exceed 3.5% of the total area of the campus.

The use of these traditional patterns and architectural styles has led to a cost advantage of 20% in the cost of construction. One of the innovations in the project was replacement of the conventional six-inch reinforced concrete cement slab, which costs as much as 115 rupees per square foot, with roofs built with hollow roof blocks, ferro-concrete rafters, and water-proofed terraces. The latter cost no more than 80 rupees per square foot. The saving is primarily due to avoidance of cement plaster, lime and painting, which is not required in the alternative suggested.

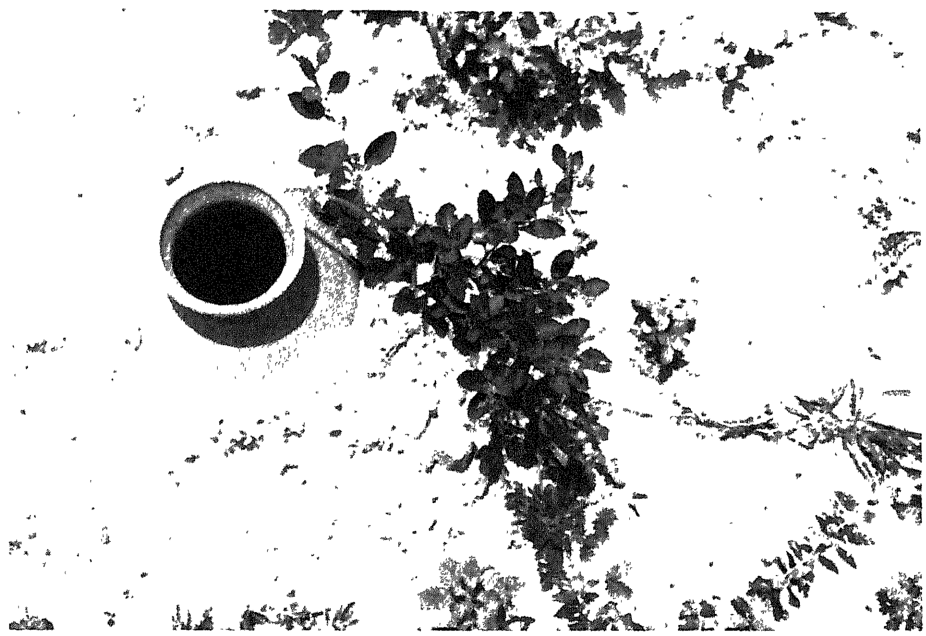
Energy generation and conservation

In order to meet the peak load demand of 160 kW, other than the sanctioned load from the state grid, the company installed an in-house infrastructure for localized power generation. It went in for a wood chip-based biomass gasifier of 63 kVA capacity, matched by a dual fuel mode generator. The saving on the fossil fuel (diesel) was as much as 70% with the use of biogas. The cost per unit of power fed by biogas was Rs 3.60 per unit as against the grid cost of Rs 5.05 per unit.

The unit was installed at a cost of 8000 rupees per kilowatt and could be amortised over a period of 70 months depending on the level of consumption. A combined use of self generated and grid power ensured a better cost feasibility per unit.

In order to improve the efficiency of generation and achieve a higher power factor, the company installed capacitance efficiency systems and also addressed the need for improving efficiency of induction. Each home was equipped with a capacitance unit saver that brought down the cost of energy by 30%. Additionally, electronic timers for street lights and auto dimmers in homes and public amenities were installed. The company is still exploring an

Watering plants is not the key. This native system of drip irrigation ensures that the root zones of young saplings receive a continuous supply of soil moisture while a tremendous saving of water is effected. This drip irrigation system consumes no more than four litres of water per plant per week against as much as 20 litres that conventional watering of plants demands. Instead of using the fragile and expensive terra cotta pots shown in this picture, one can use the cheaper recycled bottles (although plastic) with a small aperture that permits the release of no more than 2–3 drops of water a minute.



alternative solution for air conditioners through the installation of an air ambiator, which brings the ambient temperature down to a band of 21–23 °C.

Water conservation and vegetation

With a land area of 0.19 million m^2 and an annual rainfall of 914 mm, the Trans Indus team wanted to harness the 18 million litres of rainwater. They did this through a series of pits and ponds to create a storage capacity at various locations on the campus so as to retain water for a few more weeks. This water was then used for watering the vegetated beds of plants, tree saplings, and shrub species throughout the campus.

A total of 13 non-lined percolation ponds, which could hold 3.5 million litres of water were designed so as to be ecologically advantageous. The storm drains were designed to have small check bunds and percolation pits that ensured that most of the water charged the land area and did not run off or cause soil erosion. A series of rivetments and bunds transferred levels of land so as to provide protection from run-off and secure soil moisture.

The waste water management systems were localized and the conventional septic tank and soak pit system was refined to have a third chamber where the filterate from the septic tank blended with the sullage water, thereby improving the ratio of suspended solids to mass of water. The company successfully employed a system of aerobic and anaerobic digestion through a network of stoneware pipes so that most of the pollutants were treated by the compacted natural earth.

The homes were briefed about avoidance of bath tubs and on water harvesting and though the campus has three borewells, the residents were provided with a 1.4 km-long pipeline, which drew water from *Cauvery* river's city distribution line.

The company used an innovative technology of drip irrigation to water the plants. The system used recycled plastic bottles, which were filled and buried along the root zones of the growing plant. These had a small aperture, which fed no more than three drops per minute to the roots. The bottles had to be filled only twice a week and this ensured a saving on water of as much as 60 000 litres a week other than the cost saved on labour.

The Trans Indus project, when launched, defied the norms of commerce. The company had no track record and no capital to invest for creation of assets. However, the payback of the project has been such that today the company is advantageously placed. It has created a track record and has a widening clientele base.

The earnings viability of the company has enhanced considerably and the company has launched its next campus-based project as well as a chain of organic stores for distributing chemical-free organic produce.

Among the intangible benefits that have accrued is that the company has been able to attract many more creative players, and is slowly building a pool of clients who have a long-term commitment towards environmental sensitivities.

Case study at a glance

- About 140 million rupees have been invested by the company in the last seven years in the Trans Indus sustainable housing project.
- Innovations incorporated include replacement of the conventional six-inch reinforced cement concrete slab with cheaper roofs built with hollow roof blocks, ferro concrete rafters, and water-proofed terraces, which saved 25 rupees per square foot.
- A system of aerobic and anaerobic digestion through a network of stoneware pipes was employed so that most of the pollutants were treated by the compacted natural earth.
- The company installed an in-house infrastructure for localized power generation, which consisted of a wood chip-based biomass gasifier of 63 kVA capacity matched by a dual-fuel mode generator.
- To improve the efficiency of power generation, the company installed capacitance efficiency systems. Each home has been equipped with a capacitance unit saver that brings down the cost of energy by 30%.
- The unique drip irrigation system used to water the plants in the campus used recycled plastic bottles, which were filled and buried along the root zones of growing plants. These had a small aperture, which fed no more than three drops per minute to the roots. The bottles had to be filled only twice a week, saving both water and labour.

CASE STUDY

31 Nagarjuna Fertilizers and Chemicals Ltd

Background

The NFCL (Nagarjuna Fertilizers and Chemicals Ltd), part of the Nagarjuna Group, is involved in the manufacturing of urea fertilizer. The company has its complex at Kakinada on the east coast of Andhra Pradesh. The company's plant (Plant I), which is the first gas-based plant in South India, started production in August 1992 and doubled its capacity in March 1998 (Plant II). The complex uses natural gas (2.14 million cubic metres per day), naphtha (400 tonnes per day), and raw water (6.2 million gallons per day).

Environmental profile

The operational philosophy followed at the NFCL is based on total energy concept and zero liquid-effluent discharge outside the factory premises. The basic approach adopted by the company has been to prevent pollution rather than control it. It has encouraged the adoption of the environmental practice based on the hierarchy of source reduction, recycling, and treatment for the removal of pollutants and ultimate disposal to achieve this goal.

The NFCL has taken utmost care to minimize the release of pollutants (urea dust, NH_3, SO_2 [sulphur dioxide], NO_x [oxides of nitrogen], CO_2 [carbon dioxide]) release into the atmosphere. The SO_2 release from Plant I is negligible due to the use of natural gas, which contains only 1.5 PPM (parts per million) of sulphur. The naphtha usage in Plant II is being replaced by natural gas, thereby further reducing the SO_2 release.

The NFCL follows the concept of zero effluent discharge outside the plant. The entire quantity of effluent is treated and used for irrigation of a green belt. The company has a CETP (central effluent treatment plant), which acts as a back-up in case the individual effluent treatment plants of the various units within the complex fail to function. Oil-contaminated water is collected separately and treated using a disc-oil separator, which removes oil down to less than 10 PPM. Condensate from the urea vacuum concentration section is treated in deep-hydrolyser and distillation column and reused as boiler feed.

The NFCL has undertaken a number of initiatives to reduce energy and water consumption. Greater efficiency in production and use of energy contributes to resource conservation and pollution abatement. The company has changed many operational practices and optimized many process parameters throughout the complex. The overall specific energy consumption of urea has been brought down from 5.85 Mkcal/T (million kilo calories per tonne) to 5.7 M kcal/T of urea. The ammonia consumption per tonne of urea produced has improved from 0.59 MT (million tonnes) to 0.578 MT, the raw water consumption is presently 5.53 m^3/T of urea, as against an industry average of 9 m^3/T. The liquid effluent generation is about 1 m^3/T of urea as against the stipulated standard of 5 m^3/T of urea. The company recycles up to 85% of the condensates and as a result of the conservation measures, it has been able to reduce the raw water consumption from 1200 m^3/hour to 1000 m^3/hour.

Apart from general afforestation in and around the factory premises and the Kakinada town, the company has initiated many community outreach programmes. These include development of educational institutions, adoption of villages, beaches and municipal parks, cyclone relief works, and service to physically and mentally challenged children.

Case study

The NFCL believes that the social responsibility of pollution control extends beyond the narrow confines of compliance with statutorily stipulated standards. The group's aim is to maintain ecological harmony. Thus the company has developed a green belt, covering 302 hectares with 350 000 plants from 170 species. A deer park has also been developed in the green belt.

The evolution of this ecological system was the outcome of combined efforts of many eminent experts in diverse disciplines such as forestry, horticulture, and soil chemistry. The challenges faced during the development of the green belt were in terms of physiology, hydrology, vegetation, and soils. The land on which the green belt was developed was sloping towards the coastal plains and had pockets of low lands, depressions, and water-logged areas close to the sea coast. The area in general was totally devoid of vegetation, especially the water logged area to the south of the complex. High salt infestation had deteriorated the soils, and the sub-soils too had high concentrations of salts beyond the critical limits with electrical conductivity ranging from 10 to 15 umhos per centimetre. The available P_2O_5 was very low.

The NFCL made stupendous efforts to overcome these natural hindrances in order to transform the area into a green belt. Till date, 69 000 plants have been planted as mortality replacement.

The company developed innovative and varied planting techniques for the land, soil, and water profile of the area. To overcome the lack of nutrients in the soil, plants were planted in pits, which were filled with a mixture of red soil, farmyard manure, fertilizers, and gypsum. In view of the severe waterlogging, a drainage system was established so as to help the plants keep roots. Another method adopted was planting on ridges. Plants were also grown in a cluster, which would form local thickets. The low areas were filled by borrowing earth by deepening water bodies.

The company adopted a systematic approach. A detailed site and soil map was prepared so as to bring to fore the contours and the soil types. Then a survey of the sub-soil moisture availability and drainage features was done. A master plan of selected species with detailed planting procedures and schedules was made. The criteria for selection of species were based on soil and climate adaptability, availability in neighbouring nurseries, and minimum maintenance and assistance for growth. Plantation of the selected species was done on the recommendation of an expert committee.

Today, the NFCL's green belt is a thick green leaf wall, full of life, with both flora and fauna between the factory site and the town. The NFCL was the first fertilizer plant to have gone in for the development of a green belt, that too in an area that was not favourable for plantation. It stands out as a model for future industrial ventures in preserving the environment.

Some of the quantifiable environmental benefits of the project are highlighted here.

- Liquid effluents generated from the urea plant are completely utilized for green belt development, thus fulfilling the goal of zero liquid effluent discharge outside the complex.

- The green belt acts as a dust curtain and arrests the pollutant released from the plant, thus preventing air pollution. It also acts as a safety buffer physically arresting particulate matters and ammonia released from the plant.
- It helps reduce noise pollution by acting as an acoustic moderator.
- The green belt has helped improve soil fertility. The organic carbon content in the soil has gone up to 0.63% wt against the initial value of 0.01% wt. The pH in the soil has come down to 7.5 from 8.69. The mortality replacement of the plants has also gradually come down since the beginning of the programme.

Case study at a glance

The NFCL (Nagarjuna Fertilizers and Chemicals Ltd) has taken many initiatives to reduce air pollution and effluent discharge from the plant. It has also taken several initiatives to effectively conserve energy and resources. The green belt developed by the NFCL over an area of 302 hectares acts as a safety buffer physically arresting particulate matters and ammonia released from the plant. It also helps reduce the noise pollution and improve soil fertility. The approach adopted to build this green cover was well-conceived by the management. The programme involved the following technical facets.

- Preparation of a site map detailing the contours
- Preparation of a soil map to show the soil types
- Survey of the sub-soil moisture availability and drainage features
- Recommendations by the expert committee on selection and planting of the species
- Preparation of a master plan of selected species with detailed planting procedures and schedules.

CASE STUDY

32 Sesa Goa Ltd

Background

The Sesa Group of companies include the SGL (Sesa Goa Ltd), Sesa Industries Ltd, and Sesa Kembla Coke Company. The SGL, established in 1952, is involved in iron-ore mining, processing, and export. The SGL exports over 5 million tonnes of processed iron ore annually to European and Asian clients. The company has mining operations in Goa, Karnataka, and Orissa. The company has also diversified into ship-building and production of high quality pig iron and metallurgical coke.



Old workshop converted into a technical school

The SGL has been in the business of iron-ore mining and export for over 45 years and its annual turnover is about 3 billion rupees while the annual turnover of the Sesa Group is 5 billion rupees. The SGL has a workforce of about 1200 people.

In the last couple of years, the company has undertaken a research project for mine land reclamation through an integrated biotechnical approach at its Sanquelim mine in North Goa.

Environmental profile

At the SGL, mine operation and environmental management go hand in hand. Mine land reclamation is considered one of the main criteria in planning for long-term mine development. The SGL has developed its formal environment policy as per the guidelines of ISO 14001 in 1996. A separate



Students undergoing technical training in the Sesa Technical School

environment cell exists, which is equipped with the necessary laboratory facilities and instruments to monitor all relevant environmental parameters and to develop and implement mitigative measures and environmental enhancement procedures. The SGL has also received ISO 12001 certification for environmental management.

In the past, the company has undertaken a number of environmental initiatives, which are being used today as role models for other mines. Most significant among them are in the areas of power generation, mine land reclamation, and waste recycling.

Most of the mined ore requires wet beneficiation to upgrade Fe content and lower impurities. At the SGL, plant tailings after beneficiation are disposed of into exhausted pits and are treated with flocculants to separate the water from the solids. The water is recovered and recycled together with rainwater accumulated in the working pits for use in ore beneficiation. This practice ensures 100% reuse of water and zero discharge of effluents/tailings outside the mine lease. Once the pits are filled with solid tailings and overburden disposal, afforestation is undertaken.

The company had undertaken a research project entitled 'An Integrated Bio-Technical Approach for Mine Land Reclamation'. The project was initiated in collaboration with NEERI (National Environmental Engineering Research Institute), Nagpur; the Department of Biotechnology, New Delhi, and the University of Lund, Sweden. The project has been successful and the technology developed is now being promoted for reclamation of other mine sites in the region.

At other Sesa Goa mines a sequential development approach is adopted wherein a section of the mine pit is developed, the ore removed, and then the section is backfilled and reclaimed before moving to the next section.

The SGL also has a community development programme that includes providing drinking water to surrounding villages; conducting in-house training for the locals in maintenance and operation of mine machinery; providing health, first-aid, and ambulance facilities; and imparting training in sports and education.

The company has won many environmental awards; among them are the Gem Granite award for rational utilization of mineral resources and sustainable environment management and the Abheraj Boldata award for sustainable development of mineral resources – both instituted by the Federation of Indian Mineral Industries.



Overburden dump reclaimed by local flora; also seen is agri-horticultural plantation

Case study

The SGL has always laid stress on land reclamation. At present, there are 1.5 million saplings grown in an area of over 600 hectares at the company's various mine sites throughout Goa. The Sanquelim mine in North Goa, which started its operation in 1960 and was exhausted in 1988, is one of the sites reclaimed by the company.

The approach adopted was to follow the earlier experience of rehabilitating the Orosso Dongor mine, which had been exhausted in 1960. The company undertook covering of overburden clay dumps with laterite terracing and the construction of check dams, settling ponds, and planting of Acacia and cashew trees. Prior to reclamation, 'pot culture' experiments were conducted with the objective of identifying plant species suitable for mine site reclamation— species with growth potential without artificial aids like fertilizers and irrigation.

In pot culture experiments, different local species were planted on the overburden disposable sites in a dry season. An earthen pot was buried adjacent to each plant and filled with water at regular intervals. After six months, 90% plant survival was observed indicating that lack of moisture was the most inhibiting factor for growth. However, these results revealed that local flora can grow on mine-rejects in a water-deficient environment if the soil is supplemented with organic matter in the form of *neem* cake and organic manure.

In the case of the Sanquelim mine, an agri-horticultural approach was found suitable. At first, the dump was stabilized by planting *Acacia* at very close spacing, as the tree is hardy and an atmospheric nitrogen fixer. The dump soil generated eventually became rich in humus due to foliage of *Acacia*, thus resulting in initiation of soil microbial activity and further growth of the plants. A leguminous creeper was used as a cover crop in rubber plantations; this creeper, apart from fixing nitrogen, acted as mulch for water conservation, preventing soil erosion, and encouraging microbial activity.

The area took four years to stabilize. Subsequently, horticultural crops including cashew, jackfruit, coconut, banana, and mango were introduced by thinning out the *Acacia* trees. Irrigation was provided using the exhausted pit water.

The success of this programme was evident in the findings of a survey conducted by the Department of Botany, Goa University, which stated that 164 species belonging to 138 genera distributed among 55 families existed in the reclaimed mine site. These comprised grasses, legumes, climbers, shrubs,



Exhausted pits converted into pisciculture pond

and tress. More than half a million saplings grow in the Sanquelim site covering a total of 300 hectares.

The SGL also conducted experiments to investigate pisciculture, in collaboration with the National Institute of Oceanography, Dona Paula, Goa, in 1990. One of the worked-out pits (Lisboa) was terraced with loose soil to facilitate afforestation and then used for pisciculture trials. A pit is normally of 150 × 30 metres, with an average depth of water of 6 metres. The pit receives rainwater directly and a good volume of water remains in the pit throughout the year.

The pit water was initially analysed and not found suitable for pisciculture. In order to make it suitable, lime was added to reduce acidity levels and organic/inorganic nitrogen fertilizers were added to improve the nutrient content of water. Fingerlings of Rahu, Carp, and Mrugal (around 1500 in total) were released in the pit and fed daily at the rate of 5% of the body weight with soaked groundnut cakes. The water temperature was monitored daily at 1-metre depth for maintaining the feed as per the feed chart. The results were encouraging and till date the pond remains full of fish. Later on, ducks were also introduced, thus establishing a self-sustaining ecosystem.

The Sanquelim mine site today provides a model of practical land reclamation and rehabilitation demonstrating environmental and socio-economic enhancement techniques. The techniques employed in the Sanquelim mine are now being widely applied not only by the SGL, also by other major mining companies.

Case study at a glance

The SGL's management philosophy, in which mine land reclamation is considered one of the main criteria in planning for long-term mine development, has paid rich environmental dividends. With the help of internal initiatives and external agencies, the company has adopted an agri-horticultural approach for mine land reclamation. The company also restored a self-sustaining ecosystem, with the introduction of pisciculture in the mine land. The Sanquelim mine site today provides a model of practical land reclamation and rehabilitation demonstrating environmental and socio-economic enhancement techniques. Some of the significant facets of the projects are listed here.

- Covering of overburden clay dumps with laterite terracing
- Construction of check dams, settling ponds
- Pot culture experiments, in which different local species were planted on the overburden disposable sites in a dry season
- Supplementing the soil with organic matter in the form of *neem* cake and organic manure
- Stabilizing the land through planting of *Acacia* trees
- Planting of a leguminous creeper for fixing nitrogen and providing a mulch for water conservation, preventing soil erosion, and encouraging microbial activity
- Restoration of a self-sustaining ecosystem through pisciculture trials in one of the worked-out pits, which was terraced with loose soil to facilitate afforestation
- Successful reclamation and use of exhausted mine land using an agri-horticultural diversity approach: The success was evident from the fact that 164 species belonging to 138 genera distributed among 55 families existed in the reclaimed mine site. More than half a million saplings grow in the Sanquelim mine site covering a total of 300 hectares.
- Use of the mine infrastructure productively for community benefit.

CASE STUDY

33 Vestas RRB India Ltd

Background

The silent revolution in India in power generation from non-conventional energy sources, particularly wind energy, has attracted international attention. The remarkable progress India has made in this field in the last 10 years is noteworthy. Given the focus on this sector and the path chosen by India, it will make the country the leader in harnessing wind energy to generate power in the near future.

Worldwide, and in India, too, wind energy is one of the fastest growing clean energy technologies for power generation. In India, the potential for wind energy is estimated to be around 45 000 MW. As on 31 March 2001, the installed capacity for wind power in India stood at 1340 MW. Therefore, there is a huge potential for harnessing wind energy for environment-friendly power generation in India. It is estimated that around 100 000 MW of power generating capacity will be added to the Indian power grids in the next 12 years. Ten per cent of this capacity addition is going to come from renewables. Wind energy is expected to provide 6000–7000 MW of capacity addition to the grids in this period.

Given this scenario, it is important that the private sector, which already accounts for 95% capacity of wind power projects established in India, is further motivated to establish clean energy projects based on wind power. The Government of India and various state governments have given a number of fiscal and financial incentives for establishing such projects. These are as follows.

1 Nil concessional duty on import of certain components required for the manufacture of wind power generators
2 100% accelerated depreciation
3 Wind electric generators are exempted from excise duty and sales tax
4 Long-term finance through the Indian Renewable Energy Development Agency
5 Buy-back of power generation by state electricity boards at remunerative rates
6 Banking/wheeling facility
7 Third-party sale of power in certain states
8 Ten-year tax holiday on income from sale of power
9 Industry status, with attendant incentives, including capital subsidy in certain states

Case study

The project taken up by Vestas RRB India Ltd for Mohan Breweries and Distil-leries Ltd is located in Kayathar and Perungudi, Tamil Nadu. Kayathar is reputed to be one of the most windy sites in India. Around 195 wind turbines of different makes are installed in Kayathar, aggregating 117 MW. The 15-MW commercial wind power project established by Vestas RRB India Ltd is unique, being the only project of its kind to be financed by DANIDA (Danish International Development Assistance) mixed credit facility. It was co-financed by Unibank A/S, Denmark, ICICI (Industrial

Credit and Investment Corporation of India), and IFCI (Industrial Finance Corporation of India Ltd). In this project, Vestas RRB India Ltd was involved from the start to the finish in all stages and aspects of development. The 15 MW-windfarm project is distributed in two places: 5.5 MW at Kayathar in Tuticorin district, comprising 11 wind turbines, and 9.5 MW at Perungudi in Tirunelveli district, comprising 19 wind turbines. The 9.5-MW windfarm is installed over a land area of 73 hectares and the 5.5-MW project covers 42 hectares. The 30 turbines are all Vestas V39-500kW type wind electricity generators with a 42-metre rotor diameter. All power generated by these 30 turbines is being sold to the Tamil Nadu Electricity Board.

The project has the following socio-economic benefits.

- Wasteland is being used productively.
- Remote areas are provided better power supply.
- Infrastructure is developed.
- Living standards are improved.

Case study at a glance

- Windfarms supply clean and cheap energy and are one of the most important sources of renewable energy.
- Vestas RRB India Ltd has implemented many projects, one of the most crucial being the installation of a 30-wind-turbine 15 MW windfarm project for Mohan Breweries and Distilleries Ltd.
- The windfarm project was taken up from conceptualization to commercialization by Vestas RRB India Ltd.
- Located in Tamil Nadu, the windfarm is supplying electricity to the state.

Index

ANNEXE 1

CoRE-BCSD, India members

Ashok Leyland Ltd
Mr J N Amrolia
Web www.ashokleyland.com

Ballarpur Industries Ltd
Mr Neehar Aggarwal
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BG Exploration Production India Ltd
Dr Kapil Garg
Web www.bg-group.com

Bharat Heavy Electricals Ltd
Mr Rajesh Kumar
Web www.bhel.com

Bharat Petroleum Corporation Ltd
Mr M Rohatgi
Web www.bharatpetroleum.com

Bombay Suburban Electric Supply Company Ltd
Mr S S Dua
Web www.bses.com

Century Textiles and Industries Ltd
Mr B L Jain
Web www.centurytext.com

Chennai Petroleum Corporation Ltd
Mr S Pandarinathan
Web www.cpcl.co.in

Coca-Cola India
Mr T V S Krishnan

Container Corporation of India Ltd
Mr A K Kohli
Web www.concorindia.com

Continental Construction Ltd
Mr P A Kapur
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DCM Shriram Consolidated Ltd
Mr S K Agrawal
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Duncans Industries Ltd (Fertiliser Division)
Mr Bhupesh Juneja
Web www.duncansfertiliser.com

E I DuPont India Ltd
Mr Venkateshwara P B Karthikeyan
Web www.dupont.co.in

Gas Authority of India Ltd
Mr G V S Sai Prasad
Web www.gail.nic.in

Gujarat Ambuja Cements Ltd
Mr Y K Saxena
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Hindustan Lever Ltd
Mr Rajesh K Lal
Web www.hll.com

Hindustan Petroleum Corporation Ltd
Mr S G Subramoney
Web www.hindpetro.com

IBP Company Ltd
Mr K K Banerjee
Web www.ibpoil.com

ICICI Bank Limited
Mr K V Kamath
Web www.icicibank.com

ICI India Ltd
Mr Prakash G Wagle
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Indian Aluminium Company Ltd
Mr S V Jamble
Web www.indal.com

Indian Farmers Fertiliser Cooperative Ltd
Mr C P Srivastava
Web www.iffco.nic.in

Indian Metals and Ferro Alloys Ltd
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Web www.imfagroup.com

Indian Oil Corporation Ltd
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Industrial Development Bank of India
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Infrastructure Leasing and Financial Services Ltd
Mr Hari Sankaran

Jaypee Cement Ltd
Mr K V Subramanian
Web www.jiitindia.org/group.htm

Lafarge India
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Mahanadi Coalfields Ltd
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National Thermal Power Corporation Ltd
Mr S N Pandey
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Numaligarh Refinery Ltd
Mr A K Sharma
Web www.petroleum.nic.in/nrl.htm

Oil and Natural Gas Corporation Ltd
Mr A B Chakraborty
Web www.ongcindia.com

Petronet LNG Ltd
Mr Sham Sundar
Web www.petronetlng.com

Power Grid Corporation of India Ltd
Mr J Haque
Web www.powergridindia.com

Power Trading Corporation of India Ltd
Mr Mahendra Kumar
Web www.ptcindia.com

Rallis India Ltd
Mr Suresh P S Tanwar
Web www.rallis.co.in

Reliance Petroleum Ltd
Mr B S J Swamy
Web www.ril.com

Seshasayee Paper and Boards Ltd
Mr K S Kasi Viswanathan
Web www.spbltd.com

Shree Cement Ltd
Mr M K Singhi

Suzlon Energy Ltd
Mr Chintan Shah
Web www.suzlon.com

Tata Chemicals Ltd
Mr S G Choudhary
Web www.tata.com/tata_chemicals/

Tata Engineering and Locomotive Company Ltd
Mr V Krishnan
Web www.tata.com/tata_engg/

The Associated Cement Companies Ltd
Mr V J Anantharaman
Web www.acclimited.com

The Andhra Pradesh Paper Mills Ltd
Mr R C Mall

The Tata Iron and Steel Company Ltd
Mr R P Sharma
Web www.tatasteel.com

The Tata Power Company Ltd
Mr S D Deshpande
Web www.tatapower.com

ANNEXE 2 Contact details of companies

BG Exploration and Production India Ltd
Mr Kapil Garg
General Manager - Production
1st Floor, Midas, Sahar Plaza
Kondivita, MV Road
Andheri (East), Mumbai - 400 059

Biodiversity Conservation (India) Ltd
Mr Hariharan Chandrasekhar
Managing Director
609, 80 Ft. Peripheral Road
Koramangala
Bangalore - 560 034

BSES Ltd
Mr K K Saha Chaudhuri
Executive Director (DTPS & PP)
Dahanu Thermal Power Station
Village - Agwan, Dahanu Road
Thane (District) - 401 608

Chennai Petroleum Corporation Ltd
Mr S V Narasimhan
Chairman and Managing Director
536, Anna Salai, Teynampet
Chennai - 600 018

E.I. DuPont India Ltd
Mr Pankaj H Shah
President - South Asia
DLF Plaza Tower, 8th Floor
DLF Qutab Enclave, Phase - I
Gurgaon 122 002

General Motors India
Mr P Balendran
Vice President (Corporate Affairs)
VIPPS Centre
2, Local Shopping Centre
Masjid Moth, G K - II
New Delhi - 110 048

Godrej & Boyce Mfg. Company Ltd
Mr Maneck H Engineer
Vice President (Construction)
Pirojshanagar, Vikhroli
Mumbai - 400 079

Grasim Industries Ltd (Staple Fibre Div)
Mr S S Pipara
Vice President (QA & Services)
P O Birlagram, District Ujjain
Nagda - 456 331

Gujarat Ambuja Cements Ltd
Mr Y K Saxena
Asst Vice President (Environment)
248, Okhla Industrial Estate
Phase III
New Delhi - 110 020

Hindustan Petroleum Corporation Ltd (Mumbai Refinery)
Mr K Srinivasan
Deputy GM - CS & P
17, Jamshedji Tata Road
Churchgate
Mumbai - 400 020

Indian Aluminium Company Ltd (Hirakud)
Mr Rabindra Misra
Chief General Manager
Hirakud Power, P O Box 12
Sambalpur District
Hirakud - 768 016

Indian Farmers Fertiliser Co-operative Ltd (Phulpur Unit)
Mr D K Gupta
Sr General Manager
Ghiya Nagar
Allahabad - 212 404

J K Tyre (A Division of J K Industries Ltd)
Mr K Ganesan
Associate Vice President (Tyre)
P O Tyre Factory
Jaykaygram
District Rajsamand
Kanakroli - 313 342

Mahanadi Coalfields Ltd
Dr A N Sinha
Chief General Manager (Envt)
Jagriti Vihar, P O UCE Burla
Sambalpur (District) - 768 020

Mangalore Refinery and Petrochemicals Ltd
Mr A G Pai
Dy General Manager (PE&E)
Kuthethoor PO
Via Katipalla
Mangalore - 574 149

Nagarjuna Fertilizers and Chemicals Ltd
Mr V Sunder
General Manager (Works)
Nagarjuna Road
Kakinada - 533 003

Nava Bharat Ferro Alloys Ltd
Mr A E Naidu
Senior Manager (D/L)
District Khammam
Paloncha - 507 154

Oil India Ltd
Mr Amiyo Sarma
Sr Adviser (Tech.)
Allahabad Bank Building
17, Sansad Marg
New Delhi - 110 001

Orient Paper Mills
Mr A K Agrawal
Dy General Manager (Projects)
PO Amlai Paper Mills
Shahdol (District) - 484 117

Praxair India Ltd
Mr R S Dhulkhed
Vice President - Operations
Praxair House
8, Ulsoor Road
Bangalore - 560 042

Samcor Glass Ltd
Mr M M Sharma
Manager - Safety, Health & Env.
7 KM Stone
Kota-Baran Road
Naya Nohra
Ladpura
Kota - 324 001

Sesa Goa Ltd
Mr Mahesh Patil
Manager Environment
Sesa Ghor, 20 EDC Complex
PO Box 125, Patto
Panaji – 403 001

Seshasayee Paper and Boards Ltd
Mr K S Kasi Viswanathan
President (Operations)
Pallipalayam, Namakkal (District)
Erode – 638 007

Shree Cement Ltd
Mr M K Singhi
President
Bangur Nagar
PO Box No. 33
Ajmer (District)
Beawar – 305 901

Shriram Alkali & Chemicals
Mr S C Mittal
Jt VP and Unit Head, SAC
6th Floor, Kanchenjunga Building
18, Barakhamba Road
New Delhi – 110 001

Shriram Fertilisers and Chemicals
Mr K K Kaul
Vice President (Fertilisers and Power)
Shriram Nagar
Kota – 324 004

Sundaram Brake Linings Ltd
Mr R Ramasubramanian
General Manager (Operations)
Padi
Chennai – 600 050

Tamilnadu Newsprint and Papers Ltd
Mr K K Mohanan
Deputy General Manager (Envt.)
Kagithapuram (PO)
Karur (District)
Kagithapuram – 639 136
Tamil Nadu

Tata BP Solar India Ltd
Mr G Lakshminarayana
General Manager (Special Projects, HSE, IT, and Maintenance)
78, Electronics City, Hosur Road
Bangalore – 561 229

Tata Refractories Ltd
Mr S P Nepak
General Manager (Operations)
AT/PO Belpahar
Jharsuguda – 768 218

The India Cements Ltd
Mr S Gopinath
General Manager
Dalavoi Works
Sendurai Taluka,
Ariyalur District
Cement Nagar – 621 730

The Tata Iron and Steel Company Ltd
Mr R P Sharma
Head - Environmental Management
Jamshedpur – 831 001

Vestas RRB India Ltd
Mr Sarvesh Kumar
Chief Operating Officer
189, Sukhdev Vihar
New Delhi – 110 025



COMPANY PROFILE

HACH

GLI International

SIGMA

O·I·Analytical

YSI

Thermo Polysonics

Radiometer analytical

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Email: orbitech@orbitindia.com
Website: www.orbitindia.com

Industry Value Proposition

Rockwell Automation solution cuts energy consumption by 35% at New Holland Tractor India

The Indian tractor manufacturer sought a drive systems solution along with new monitoring systems and an energy fix that would pay for itself in a short amount of time. Through energy reduction, the upgrade paid for itself within 13 months.

Background

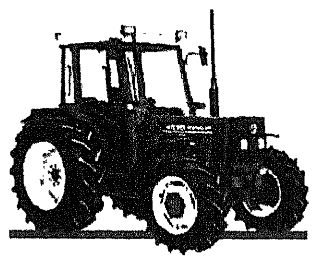
New Holland roots go back to its namesake, the small U.S. town of New Holland, Pennsylvania. The New Holland Machine Company opened its doors in 1895 as a one-man machine repair shop and went on to carve its niche in the 20th century as an innovator of agricultural equipment that is made and sold around the world and has standardized on Rockwell Automation products.

New Holland Tractors has one of its wholly owned subsidiaries in India and is a leader in the local market and a major player on the global stage. When the facility, located in Greater Noida, near New Delhi, opened its doors in 1998, it specified the inclusion of Allen-Bradley control systems. Today, the plant produces 1,000 units a month and serves 10% of the Indian tractor market with annual sales of US$ 100 million.

Challenge

Energy waste in the compressor line throughout the Indian plant was having a negative effect on profit margins. The company sought to improve energy waste by introducing control and monitoring systems that would minimize energy losses and reduce mechanical and electrical breakdowns in the compressor unit.

In the compressor line, excessive energy waste and pressure variation affected seven different departments in the plant, including the paint shop, assembly line, utility area, engineering and machine shop. Increases and decreases in air pressure required constant management because requirements varied from department to



department. Great quantities of energy were wasted because the motor would run at full speed when the compressor switched between load and no load conditions.

To reduce costs and improve its competitive position, New Holland India decided to decrease power consumption and improve energy system monitoring of such things as voltage, current, power factor, load and harmonics. The challenge was to achieve this with a small investment that delivered a quick payback.

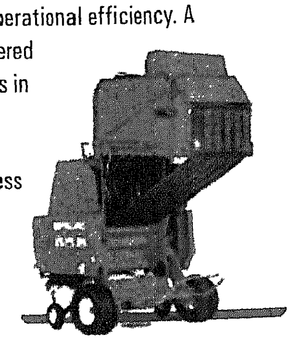
Solution

New Holland India sought answers from the local System Integrator M/s Elcon System Pvt. Ltd., which partnered with Rockwell Automation for a solution.

Working together, the Elcon/Rockwell Automation team proposed a plan that helped New Holland with the decision making process. The team gave the manufacturer a demonstration and a 10-day trial period. The company quickly assessed long term savings and chose Elcon/Rockwell Automation over its competitors.

The solution included the installation of a pressure transmitter at the input point of the pressure line and an Allen-Bradley 125HP Variable Frequency Drive (VFD) to vary the motor speed automatically. The features allowed the motors to run at low speed when more pressure was required and immediately saved energy and improved the power factor to unity.

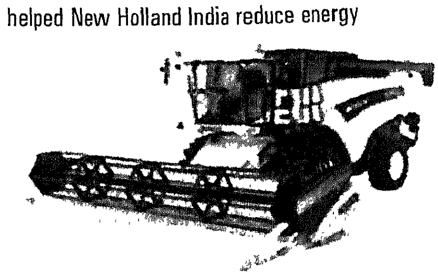
With the AC variable speed drive, New Holland could automatically adjust pressure during various operating conditions without losing operational efficiency. A solution that offered maximum savings in energy costs.



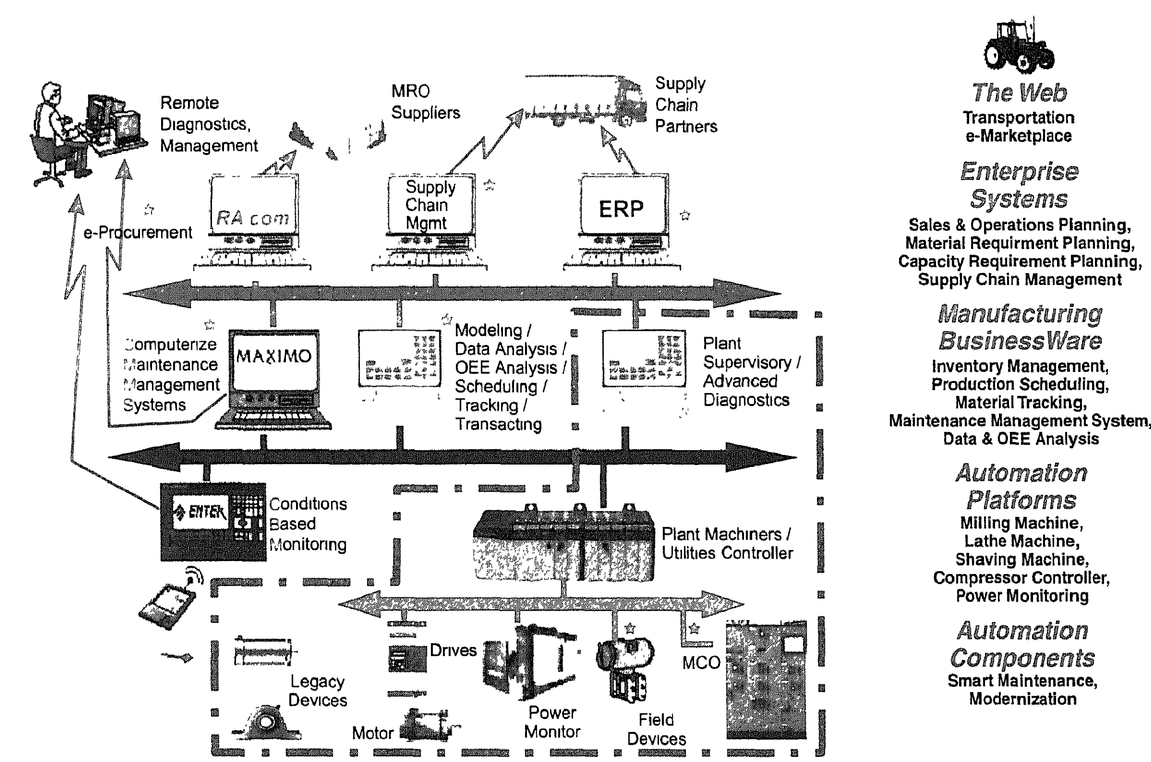
Monitoring process details for critical parameters as the power factor, harmonics and demand load, was achieved with the installation of power monitors connected to a network running a specialized power software RSPower32. One monitor was placed in each of the plant's seven key departments and included six-PM3000 and 1-PM2. Energy calculations were now achieved automatically along with easy monitoring of such things as tripping, voltage dipping and power failure.

Results

The Rockwell Automation/Elcon solution helped New Holland India reduce energy



INTEGRATING PLANT FLOOR THROUGH THE ENTERPRISE AND BEYOND



☆ Information Enabled Enterprise – Complimentary Optional Linkages

▬ ▪ ▬ Present automation system including existing Motors, MCCs, Field & Legacy Devices, etc

consumption by 35% and the system now operates automatically with no manual intervention.

Without losing efficiency of its operation, New Holland achieves their savings due to their new ability to automatically vary their pressure amounts. The savings means the company will have paid for its investment within 13 months, a key objective from the start of the project.

The company also reports they are now getting automated regular reports for each department and are able to track various trends and data, which have increased efficiency. Money wasting breakdowns are now prevented with the expansive energy calculations. Moreover, the company is now able to measure and correlate power consumption with production output.

New Holland India assistant manager and plant engineer Pawan Uppal said he is extremely happy with the results. "The realization of savings by controlling our compressors has been a remarkable achievement," he said, adding that the "support system was key in the operational success."

New Holland India plans to involve Rockwell Automation in future energy saving undertakings and PLC/SLC based automation projects.

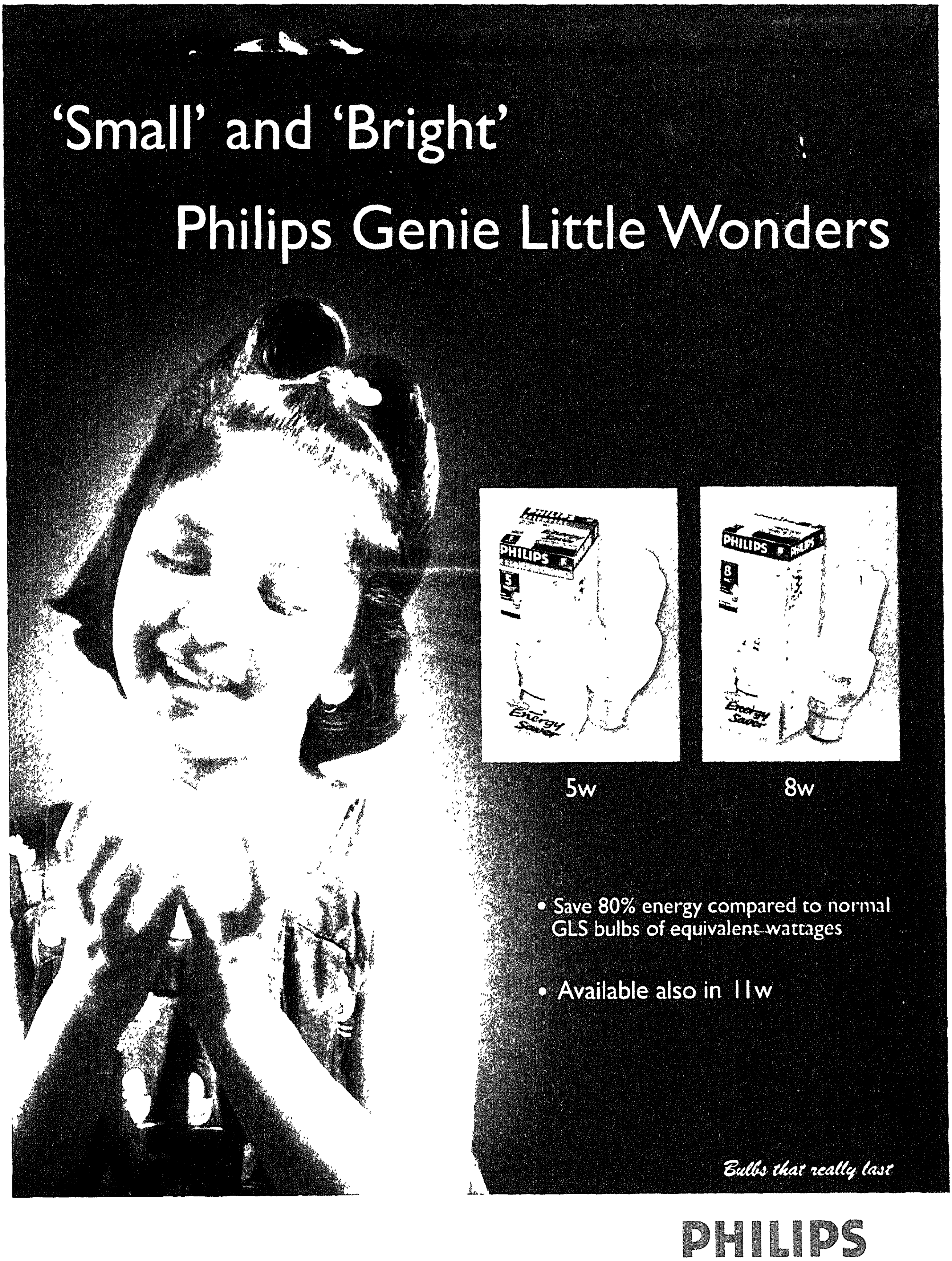
The above architecture depicts Rockwell Automation's concept of an Information Enabled Enterprise. The area outlined with a brown dash line represents the present automation level under discussion in this document. The remaining portion illustrates a host of solutions that Rockwell Automation can provide today to integrate the plant floor to the enterprise and beyond.

Rockwell Automation

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Allen-Bradley

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